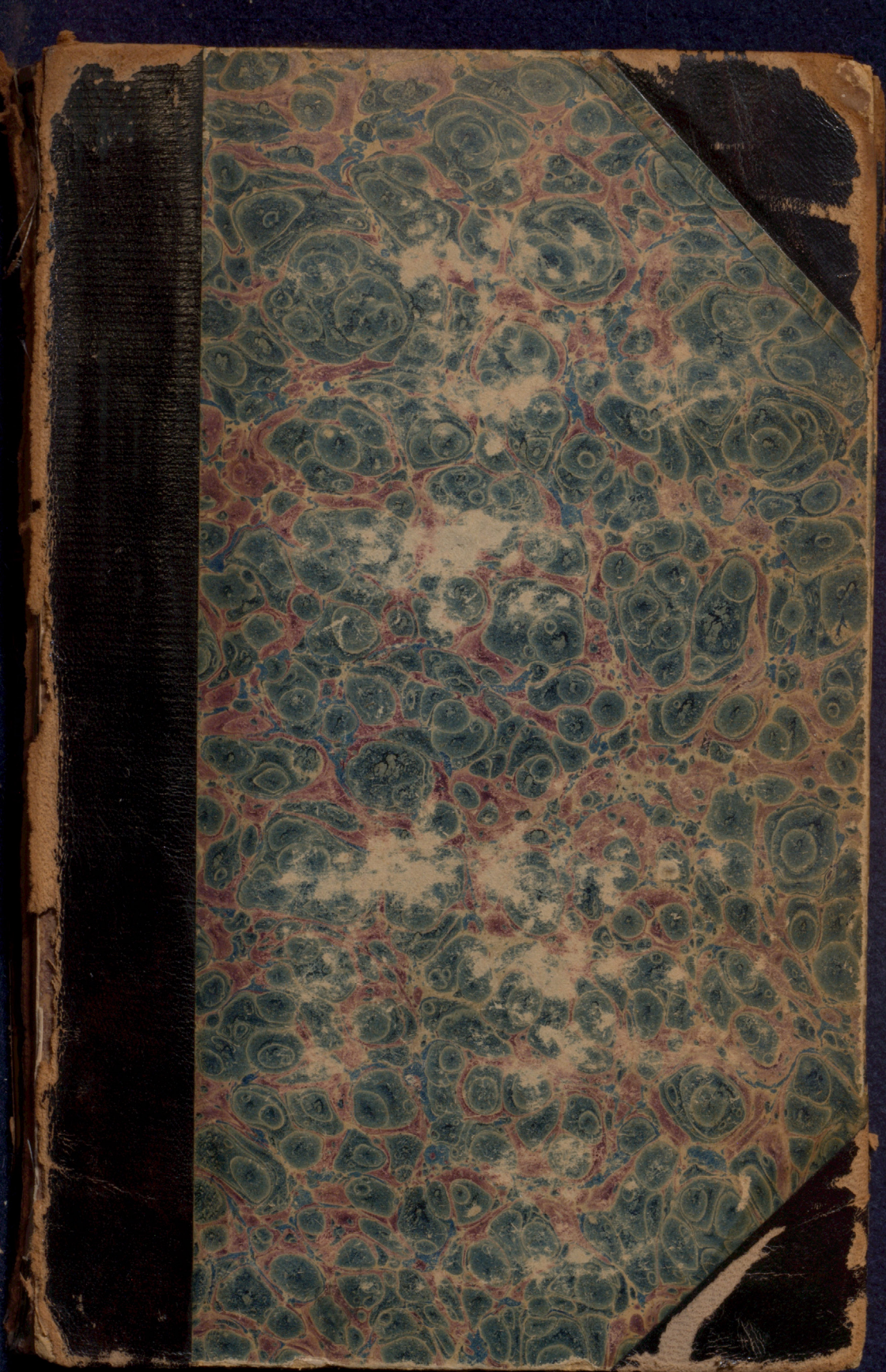




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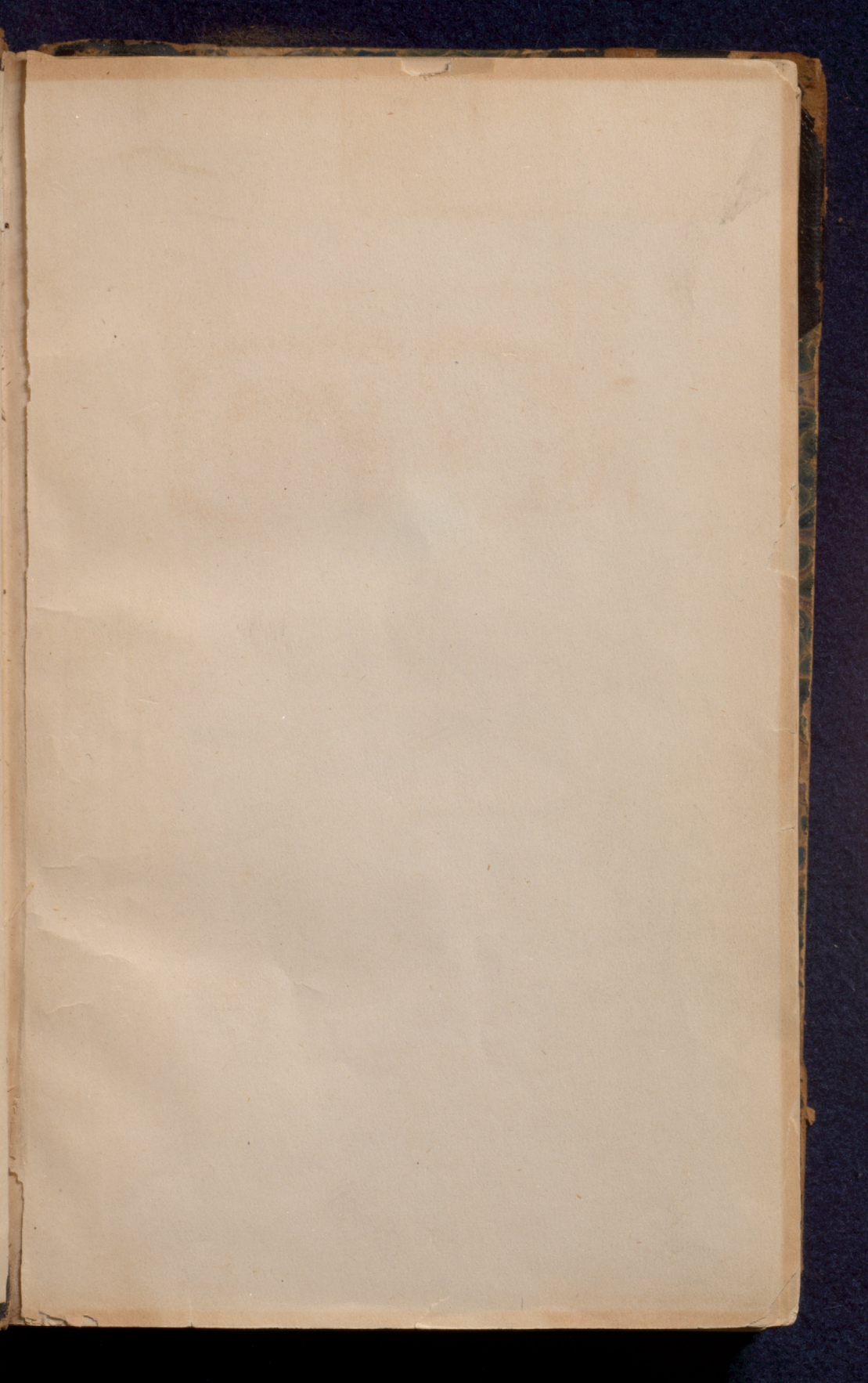


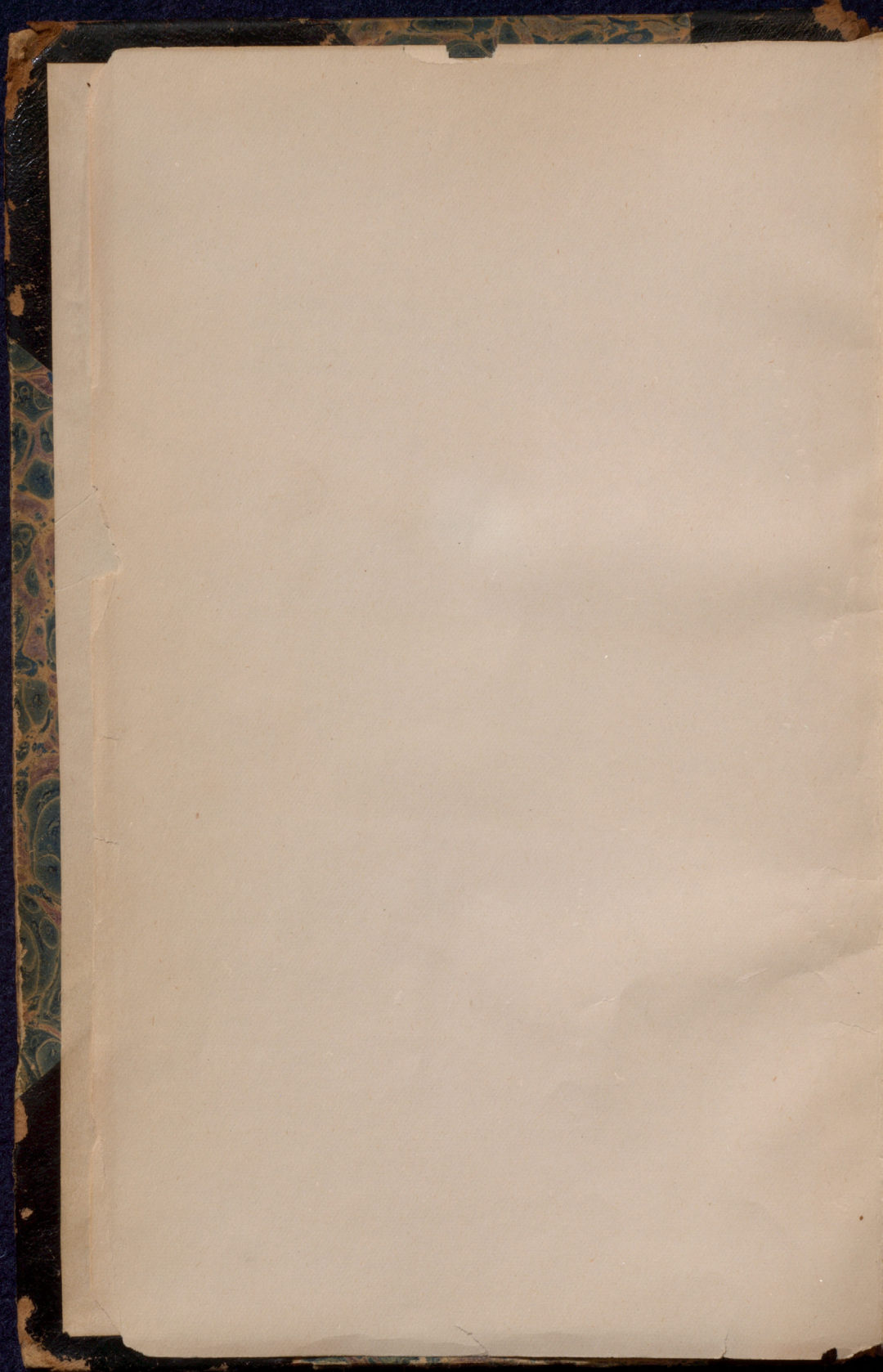
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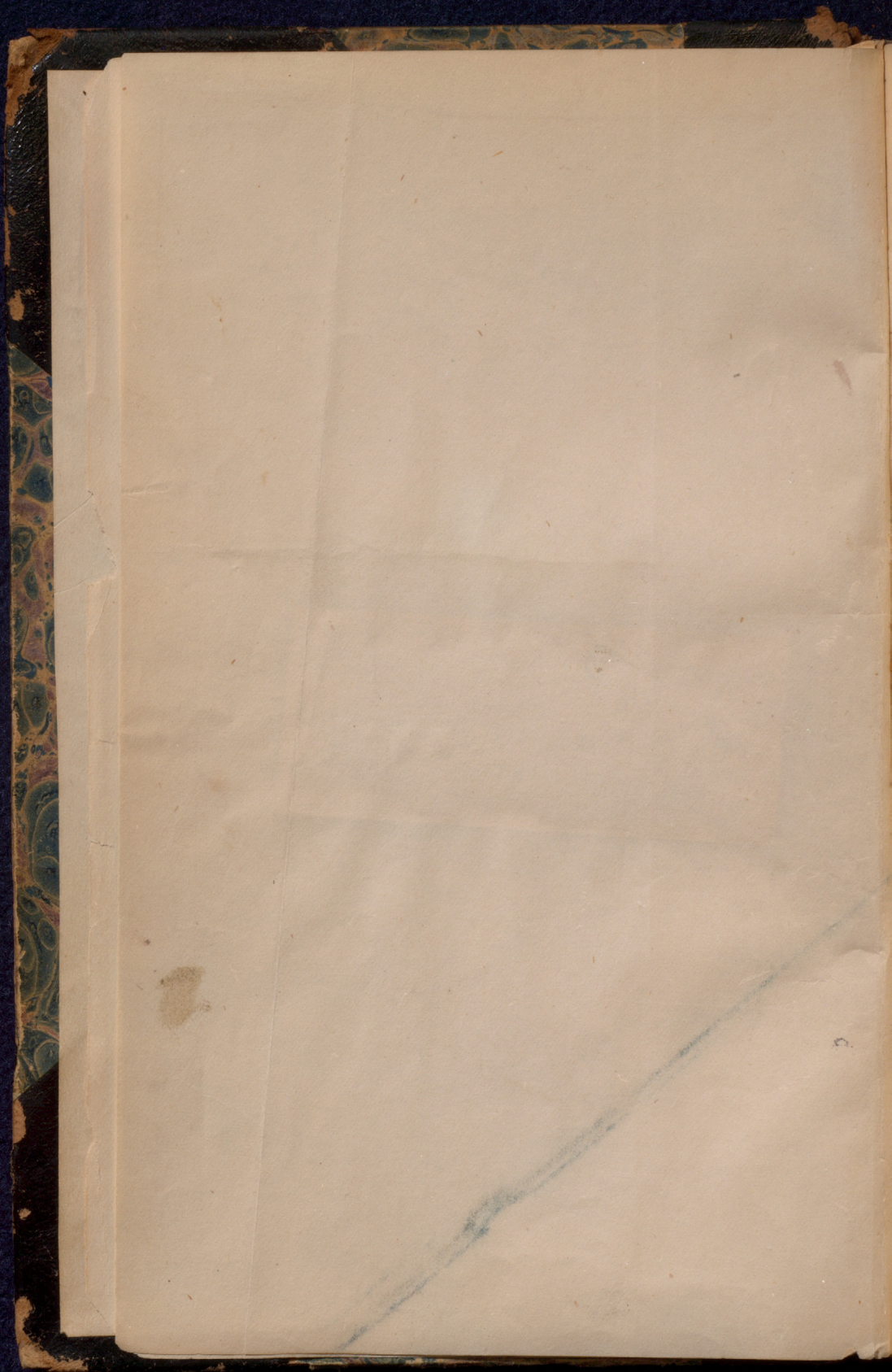
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- 1 *Papus* *Ind*
- 2 *Williamson* *Volcanaria* *Dumini*
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- 3 *Do*
- 4 *et* *Wholm* *Plants* *Heddon* *States*
- 5 *William* *Calamitum* *Stubs*
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- 13 *Do* *Ulodendron*
- 14 *Do* *Fruits* *of* *Coal* *Forest*
- 15 *Do* *Abundant* *Geopods*
- 16 *Do* *Thinned* *head* *feet*
- 17 *Do* *Brachian* *Plants*
- 18 *William* *Long* *Stems*
- 19 *William* *Eophyton*
- 20 *Geopod* *&* *Germs* *Volm* *and* *Plants*
- 21 *Strophomena* *on* *Calamites*

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ON THE
PRE-CARBONIFEROUS FLORA
OF

NEW BRUNSWICK, MAINE, AND EASTERN CANADA.

BY J. W. DAWSON, LL.D., F.G.S., &c.

(From *Canadian Naturalist* for May, 1861.)

The known flora of the rocks older than the Carboniferous system, has until recently been very scanty, and is still not very extensive. In Goeppert's recent memoir on the flora of the Silurian, Devonian, and Lower Carboniferous rocks,* he enumerates 20 species as Silurian, but these are all admitted to be Algæ, and several of them are remains claimed by the zoologists as zoophytes, or trails of worms and mollusks. In the Lower Devonian he knows but 6 species, five of which are Algæ, and the remaining one a *Sigillaria*. In the middle Devonian he gives but one species, a land plant of the genus *Sagenaria*. In the upper Devonian the number rises to 57, of which all but 7 are terrestrial plants, representing a large number of the genera occurring in the succeeding Carboniferous system.

Goeppert does not include in his enumeration the plants from the Devonian of Gaspé, described by the author in 1859;† having seen only an abstract of the paper at the time of writing

* Jena, 1860.

† Journal of Geological Society of London, also Canadian Naturalist.

his memoir, nor does he appear to have any knowledge of the plants of this age described by Lesquereux in Rogers' Pennsylvania. These might have added ten or twelve species to his list, some of them probably from the Lower Devonian. It is further to be observed, that certain specimens found in the Upper Ludlow of England,* appear to prove the presence of *Lepidodendron* in that formation; and that in the paper above referred to, I have noticed specimens from the Gaspé limestone which seem to me to indicate the occurrence of *Psilophyton* and *Noeggerathia* or *Cordaites* in the Upper Silurian of Canada.

It thus appears that, according to our present knowledge, the plant life of the land, so rich in the coal formation, dies away rapidly in the Devonian, and only a few fragments attest its existence in the Upper Silurian. Great interest thus attaches to these oldest remains of land plants; and fragmentary though they are and often obscure, they merit careful attention on the part of the geologist and botanist.

No locality hitherto explored, appears more favourable to the study of this ancient vegetation, than those parts of Eastern America to which this paper relates. The Gaspé sandstones have already afforded six Devonian species, some of them of great interest, and in a remarkably perfect state of preservation; and from beds of similar age in New Brunswick and Maine, I am now prepared to describe at least ten species, most of them new. This already raises the species found in the band of Devonian rocks, extending through the north-eastern States of the Union, and the eastern part of British America, to one-third of the number found in all other parts of the world; and the character of the containing rocks, the number of nondescript fragments, and the small amount of exploration hitherto made, justify the hope that a much larger number may yet be discovered.

Of the plants described in this paper, only a few have been discovered by myself. The greater part are from the following sources. (1) The collection of Mr. G. F. Matthew, of St. John, New Brunswick; (2) a collection from Perry, Maine, made by Mr. Richardson for the Geological Survey of Canada; (3) specimens from Perry in the collection of the Natural History Society of Portland. Several of these plants have been long known. Some of those found at St. John are noticed by Dr. Gesner in his re-

* Murchison's Siluria, p. 152, Journal Geol. Socy. Vol. IV.

port on the geology of New Brunswick; and specimens were shown to me several years ago, by the late Professor Robb of Fredericton. Those from Perry are mentioned in the report of Dr. Jackson on the geology of Maine, and have also been noticed by Prof. Rogers in the proceedings of the Natural History Society of Boston. No adequate description of them has however yet been published; and it is to this task that I would address myself in the present paper. I shall notice first the plants from St. John, next those from Perry, and finally a new form from Gaspé.

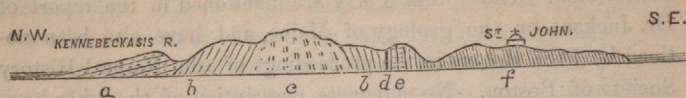
1. ST. JOHN, NEW BRUNSWICK.

The city of St. John stands on the rocks constituting what I have elsewhere termed the coast metamorphic belt of New Brunswick,* an irregular ridge rising through the Carboniferous rocks, and extending from Shepody mountain south-westward along the north side of the Bay of Fundy to the St. John River, westward of which it expands into a broad band of metamorphic and plutonic rocks, extending into the State of Maine. In the vicinity of St. John these rocks consist principally of white and gray crystalline limestone, hard shales and slates of various colours and qualities, quartz rock, and indurated gray sandstone. With these are associated syenite, greenstone, and trappean rocks, some of the latter appearing to be interstratified. The crystalline limestone is of great thickness and destitute of fossils; but contains small quantities of graphite. In the shales near the limestone is a regular bed of graphite, attaining in places a thickness of four feet. It is of coarse quality, and retains obscure traces of vegetable structure. Some of the beds of sandstone and shale contain numerous fossil plants, their carbon being in the state of graphite, and the fragments, though abundant, not easily studied, owing to their imperfect preservation, and the hardness of the enclosing rock. A bed of sandy shale is filled with fragments of *Lingula*, which were discovered by Prof. Rogers, but which neither he nor Mr. Billings, to whom I have shown specimens, can refer to any known species.

The arrangement of the beds at St. John is shown by the ac-

* Acadian Geology.

companying section prepared by Mr. Matthew, and which accords with such observations as I have been able to make.



Section of the vicinity of St. John.

(a) Lower carboniferous conglomerate. (b) Crystalline limestones of St. John group. (c) Syenite. (d) Bed of graphite. (e) Interstratified trappean rock. (f) Slates, shales, and sandstones of St. John group.

With respect to the age of these beds; in the absence of determinable animal fossils, I may state the following facts. (1) The limestone and its associated shales underlie unconformably the Lower Carboniferous conglomerate, which here appears to be the oldest member of that system. This arrangement is general throughout the belt to which the St. John rocks belong. (2) The whole of the beds of the St. John group, appear to be conformable to one another and to constitute one formation. (3) In mineral character, and especially in the occurrence of thick beds of limestone and of graphite, the St. John rocks do not resemble any of the Devonian or Silurian rocks of Nova Scotia, though these occur in a similar state of metamorphism. They more nearly resemble the Devonian of Gaspé. The Devonian rocks known in Nova Scotia, appear to belong to the lower rather than to the upper member of that system,* and they have afforded no plants except indeterminable fragments. (4) The plants found in the rocks of the St. John group, are specifically distinct from those of the Carboniferous system in Nova Scotia and New Brunswick.

In the map attached to Prof. Johnston's Report on the Agriculture of New Brunswick, Prof. Robb has coloured these rocks as Lower Silurian. In my *Acadian Geology*, on the ground chiefly of mineral character, I have with doubt placed them as Upper Silurian or Devonian. The facts at present known show them to be older than the Carboniferous system, though perhaps belonging to the newest part of the Devonian.

The following are the plants which I have been able to determine:—

* Supplement to *Acadian Geology*, also *Canadian Naturalist*, Vol. 4.

1. *Dadoxylon Ouangondianum*. *—Sp. nov.

Fig. 1.

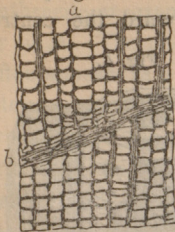
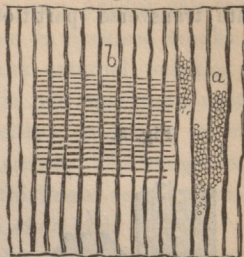


Fig. 2.



Figs. 1 and 2.—*Dadoxylon Ouangondianum*.

Fig. 1.—Transverse section 50 diams. (a) Wood cells. (b) Line of growth.

Fig. 2.—Longitudinal section, radial. (a) Disc structure. (b) Medullary rays.

Description.—Branching trunks, with distinct zones of growth, and a pith of *Sternbergia* type. Wood cells very large, with three to five rows of contiguous alternate hexagonal areoles with oval pores. Medullary rays with one to three series of cells, and as many as 14 rows of cells superimposed on each other.

Trunks of this fine coniferous tree are not infrequent in the St. John sandstones explored by Mr. Matthew. They retain their structure in great perfection, especially in silicified specimens. Some of the trunks have been a foot or more in diameter. They show traces of growth rings on their weathered ends, and when perfect, are traversed by the transversely wrinkled pith cylinders, formerly known as *Sternbergiae*. Under the microscope the wood cells are seen to be of remarkable size, being fully one-third larger in their diameter than those of *Pinus strobus* or *Araucaria Cunninghami*, and also much larger than those of the ordinary coniferous trees of the coal measures. They are beautifully marked with contiguous hexagonal areoles, in which are inscribed oval slits or pores, placed diagonally. The medullary rays are large and frequent, but their cells, unlike the wood cells (prosenchyma), are more small and delicate than those of the trees just mentioned. The pith when perfectly preserved, presents a

* I have named this species after the ancient Indian designation of the St. John River, *Ouangonda*. I use the generic term *Dadoxylon* as probably best known to English geologists; but I sympathise with Goeppert in his preference of the generic term *Araucarites* for such trees.

continuous cylinder of cellular tissue, wrinkled longitudinally without, and transversely within, and giving forth internally delicate transverse partitions which coalesce toward the centre,

Fig. 3.

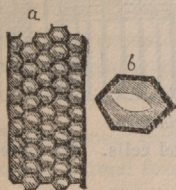


Fig. 4.

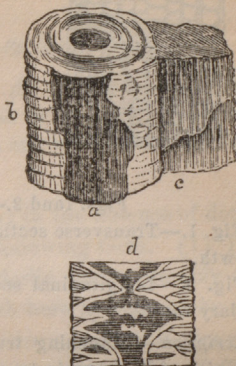
Figs. 3 and 4.—*Dadoxylon Ouangondianum*.

Fig. 3.—Fragment of wood cell prepared by nitric acid. (a) 200 diameters. (b) Single areole more highly magnified.

Fig. 4.—*Sternbergia* pith. (a) Outer carbonised coating. (b) Transverse plates. (c) Fragment of wood attached to exterior. (d) Section showing internal structure, natural size.

leaving there a series of lenticular spaces, a peculiarity which I have not heretofore observed in these *Sternbergia* pith cylinders. It is interesting to find in a Devonian conifer the same structure of pith characteristic of some of its allies in the coal formation, where however, as I have elsewhere shown,* such structures occur in *Sigillaria* as well; and since Corda has ascertained a similar structure in *Lomatofloyos*, a plant allied to *Ulodendron*, it would appear that the *Sternbergia* may have belonged to plants of very dissimilar organization.

In my specimen the pith is only half an inch in diameter, and only a small portion of the wood is attached to it; but Mr. Matthew has a specimen of a trunk ten inches in diameter, with the pith one inch in thickness, and another $11\frac{1}{2}$ inches in diameter, with the pith $2\frac{1}{2}$ inches. Both had the appearance of decayed trunks, so that their original size may have been considerably greater.

* Paper on Coal Structures. Journal of Geol. Survey.

Mr. Matthew states in reference to the mode of occurrence of this interesting species, that the wood is always in the state of anthracite or graphite, or mineralized by iron pyrites, calc spar or silica. The pith is usually calcified, but in pyritised trunks it often appears as a sandstone cast with the external wrinkles of *Sternbergia*. The pith is often eccentric, and specimens occur with two or three centres; but these either consist of several trunks in juxtaposition, or are branching stems. The annual layers vary from $\frac{1}{8}$ th to $\frac{1}{30}$ th of an inch in thickness, and adjoining layers sometimes vary from $\frac{1}{10}$ th to $\frac{1}{20}$ th of an inch.

The trunks of this species appear to have had a strong tendency to split in decay along the medullary rays, and in consequence the cross section often presents a radiating structure of

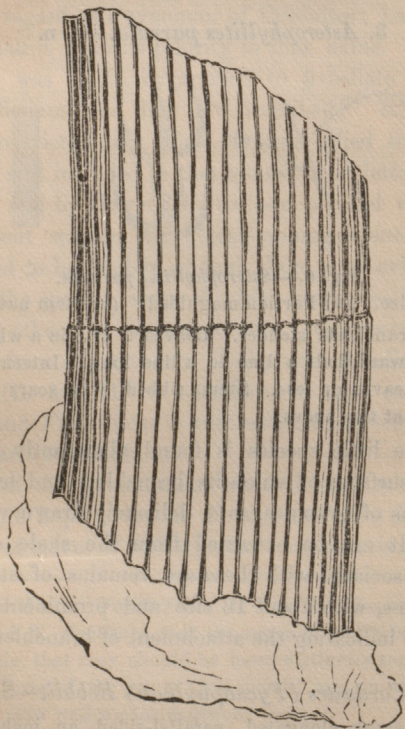


Fig. 5.—*Calamites transitionis*. (p. 168.)

alternating black lines representing the wedges of wood, and white rays of calc spar. The heart wood seems to have had its cell

walls much thickened, and in consequence to have been more durable than that nearer the surface. They appear to have been drift trees, and to have been much worn and abraded before they were imbedded in sediment.

2. *Calamites transitionis*.—Goeppert.

(Fig. 5—previous page.)

The specimen figured appears to belong to the species above named, which occurs in the Devonian of Silesia, and also in the Lower Coal Formation. It is a cast in sandstone, showing merely the decorticated surface in an indifferent state of preservation. Specimens of this species were shown to me in 1857, by the late Prof. Robb, and were the first well characterized plants from the St. John rocks, that had come under my notice.

3. *Asterophyllites parvula*.—S. n.



Fig. 6.—*Asterophyllites parvula*.

(a) Natural size. (b) Portion magnified. (c) Stem natural size.

Description.—Branchlets slender. Leaves 5 or 6 in a whorl, subulate, curving upward, half a line to a line long. Internodes equal to length of leaves or less. Stems ribbed, with scars of verticillate branchlets at the nodes.

This delicate little species is found abundantly in graphitic shale, on the surfaces of which its branchlets and leaves appear as shining films of graphite, as if delicately drawn with a black lead pencil. It can be extracted from the shale only in fragments; but associated with these are remains of stems about a line in thickness, with about 16 ribs and prominent nodes with little tubercles indicating the attachment of branchlets.

4. *Cordaites (Pycnophyllum) Robbii*.—S. n.

Description.—Leaves elongated, parallel-sided, an inch or more in width, with very delicate equal longitudinal striæ.

This is the characteristic plant of the graphitic shale above mentioned, to which its leaves, converted into graphite, aid in

giving a thin lamination. For this reason I desire to dedicate it to my late lamented friend, Prof. Robb, who has been called away in the midst of labours that would have added much to our knowledge of the geology of New Brunswick. I have seen no specimens of this leaf entire; but it appears to have been a broad lanceolate or oblong leaf, resembling the common *Cordaite*s of the coal measures, but more delicate in its striation. Mr. Matthews has found specimens 3 inches in width.

The generic name *Cordaite*s as used here, may require some explanation. I employ it as applied by Unger to the *Flabellaria borassifolia* of Corda, which I regard as the type of all those broad parallel-veined elongated leaves, which have by various authors been placed in the genera *Pycnophyllum*, *Noeggerathia*, *Poacites*, and *Flabellaria*. The first of these names, proposed by Brongniart, I regard as a synonym of *Cordaite*s; but I have no certain information as to its priority to that name. The second, *Noeggerathia*, was originally applied to flabellate and pinnate leaves, quite distinct from that now described.* It has by some authors been restricted to a genus of ferns allied to *Cyclopteris* and by others still included in that genus;† and latterly it is used by Goeppert,‡ and by Unger,§ to include parallel veined leaves, like the present species, but placed among monocotyledonous plants, and said to be pinnate, though there is no evidence of this in several of the species, some of which may possibly belong to *Cordaite*s, and others, as *N. tenuistriata*, (Goeppert,) are probably stipes of ferns allied to my *Cyclopteris Acadica*. *Poacites*, if *P. cocoïna* (L. and H.) is considered its type, cannot include these leaves, and *Flabellaria* is now restricted to leaves of palms, quite dissimilar from *Cordaite*s.

By the use of the generic name which I have selected for the above reasons, I hope to avoid all the confusion in which the nomenclature of leaves of this type has long been involved. I do

* Lindley and Hutton, Fossil Flora. It is to these leaves, represented by *N. foliosa* and *N. flabellata*, that the name properly belongs, and it appears desirable that they should be more distinctly separated on the one hand from ferns of the genus *Cyclopteris*, and on the other from plants like that now under consideration.

† Lesquereux in Rogers' Pennsylvania. See also Unger, Genera et Species, and Goeppert, Gattung.

‡ Flora des Uebergangsgebirges, and Flora der Silurischen, &c.

§ Unger Palæontologie des Thüringer waldes.

not express any opinion as to their affinities, any farther than to state my belief that they present no important point of structural difference from *Cordaites borassifolia*, and that this plant as described by Corda,* has a stem closely resembling *Lomatoflojos*, and therefore of the same type of structure with *Ulodendron* and *Lepidodendron*.

5. *Cordaites angustifolia*.—S. n.

Description.—Leaves elongated, one-tenth to one-fourth of an inch wide, with delicate equal parallel striae.

This leaf differs from the last in its proportionate narrowness and decided striation. No specimen showing its extremities has been obtained, in consequence of which, I cannot determine whether it has the retuse apex mentioned as one of the characters of Unger's *Noeggerathia graminifolia*, which in form and dimensions it much resembles. A very similar leaf, probably the same species, occurs in the Devonian and Upper Silurian of Gaspé, and is represented in Fig. 11. It was noticed in my paper on the plants of that region, as probably a *Noeggerathia*.

6. *Sphenophyllum antiquum*.—S. n.

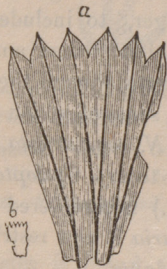


Fig. 7.—*Sphenophyllum antiquum*.

(a) Magnified. (b) Natural size.

Description.—Leaflets cuneate, one-eighth of an inch wide at apex, and less than one-fourth of an inch long. Nerves three, bifurcating equally near the base, the divisions terminating at the apices of six obtuse acuminate teeth.

This is the first occurrence, in so far as I am aware, of the genus *Sphenophyllum* in beds older than the carboniferous system. Leaflets only were found, so that it is impossible to state the arrangement of these on the stem; but the form and nerva-

* Flora der Vorwelt; under genus *Flabellaria*.

tion of the leaflets are well defined. Under the microscope the nervures have a striated appearance, and there is a more delicate longitudinal striation visible in the epidermis of the leaf. I may remark here, that though in a somewhat altered rock, and to a cursory glance indistinct, the leaves and other delicate vegetable organs in the shales of St. John, are found under the microscope to present an unusual degree of perfection in their finer markings. They must in the first instance have been imbedded in a quite unchanged condition, and but for the alteration which the rocks have sustained, would have furnished remarkably perfect specimens. The species above described approaches most nearly to *S. erosum* of the coal measures, but differs in its proportions.

7. *Lycopodites Matthewi*.—S. n.

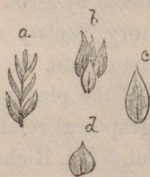


Fig. 8.—*Lycopodites Matthewi*.

(a) and (b) Natural size. (c) Magnified. (d) *Lepidophyllum*.

Description.—Leaflets one veined, narrowly ovate-acuminate, one-tenth to one-fourth of an inch in length, somewhat loosely placed on a very slender stem, apparently in a pentastichous manner.

This pretty little species is abundantly displayed in graphite, in the Cordaites shale I have already referred to. With it are found the little scales or *Lepidophylla*, (Fig. 8, d.) which may possibly have belonged to its fructification.

In addition to the above plants, there is in the sandstone containing conifers, an impression of the bark of a plant which may have been a *Sigillaria*. In the Cordaites shale there are many indeterminable fragments, among which are a small fern leaf, apparently a *Sphenopteris* like *S. Devonica*, Unger, a terminal pinule of a *Cyclopteris*, which appears to be the same with that described below from Perry, leaves having the appearance of those of *Sigillaria*, (*Cyperites*), and stems which may belong to *Psilophyton*. There are also some remarkable fragments which

in some aspects appear to be transversely furrowed stems with longitudinal striæ, and in other specimens present the appearance of monocotyledonous leaves, with strong longitudinal nerves and more slender transverse ones. These are perhaps stipes of ferns, some species of *Cyclopteris* presenting a somewhat similar appearance in their flattened petioles. There also occur both at St. John and Gaspé, carbonaceous films of uncertain form, and minutely pitted all over, the precise nature of which I cannot determine.

II. PERRY, MAINE.

The rocks at this place consist of sandstones and shales, very closely resembling those of Gaspé. They were first described by Dr. Jackson, in his Report on the Geology of Maine. More recently they have been noticed by Prof. Rogers, in the Proceedings of the Natural History Society of Boston. Prof. Rogers regards them as of Devonian date, in which view Dr. Jackson concurs, and the evidence of the plants is favourable to the same conclusion. Their stratigraphical relations have not, however, been accurately worked out. Mr. Richardson, of the Geological Survey of Canada, represents them as apparently resting unconformably on metamorphic rocks of uncertain date, but which, according to some recent observations of Prof. Rogers, may be in part of Upper Silurian age. The fossils from this place which have come into my hands, are preserved somewhat imperfectly in hard coarse sandstone. They consist of the following species:—

1. *Cyclopteris Jacksoni*.—S. n.

I think it but just to name this fine species after its original discoverer, and the explorer of the geology of Maine. It is closely allied to *C. Hibernica* and *C. McCoyana* from the Devonian of Ireland; but is sufficiently distinct to constitute a well marked species. It resembles the ferns just named in the dense arrangement of its pinnules, which largely overlap each other; but it differs from them in the arrangement of the pinnæ, in the form of the pinnules, and in the character of the rhachis. It seems quite distinct from any of the ferns from the Devonian of Pennsylvania, &c., described by Lesquereux. The specimen figured is one in the collection of the Natural History Society of Portland.

In Mr. Richardson's collection, single pinnæ occur, and there are also many large stipes which may have belonged to this species.



Fig. 9.—*Cyclopteris Jacksoni*.

(a) Terminal pinnule. (b) Lateral pinnules slightly magnified.

Description.—Frond bipinnate; rachis stout and longitudinally furrowed; pinnæ alternate; pinnules obliquely obovate, imbricate, narrowed at the base, and apparently decurrent on the petiole; nerves nearly parallel, dichotomous; terminal leaflet large, broadly obovate or lobed.

As above stated, terminal pinnules which may have belonged to this species occur in the St. John beds; but more

perfect specimens will be required to render this identification certain.

2. *Lepidostrobus Richardsoni*.—S. n.

(Fig. 10.)

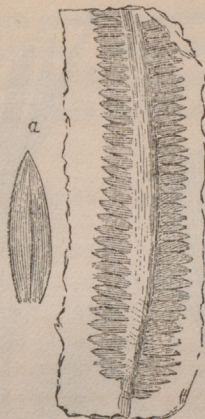


Fig. 10—*Lepidostrobus Richardsoni*.

(a) Pinnule magnified.

Description.—Axis not distinctly preserved, form cylindrical?—scales oblong with an obscure midrib.

I refer to the above genus with some hesitation, a well characterised but very puzzling organism, discovered by Mr. Richardson at Perry. It consists of an indistinct but apparently thick stem or axis, with equally pinnate leaves, which seem to have been thick and oblong and show traces of a midrib. It resembles a perfectly flattened *Lepidostrobus*, more than anything else; but it may have been a branch of a conifer with pinnate leaves.

3. *Lepidostrobus*, ————— S. n.

In Mr. Richardson's collection from Perry, is a rounded and flattened object, $1\frac{1}{2}$ inch in diameter, apparently covered with thick pointed scales. It seems to be a *Lepidostrobus* quite distinct from the last.

4. *Lepidodendron Gaspianum*.—mihi.

In a specimen in the collection of the Natural History Society of Portland, there is a branch of *Lepidodendron*, $7\frac{1}{2}$ inches in length, $\frac{1}{2}$ inch in diameter at the larger end, and $\frac{1}{3}$ inch in dia-

meter at the smaller. It is flattened and imperfectly preserved, but on comparison with my specimens from Gaspé, I cannot observe any specific difference. This species is evidently closely allied to *L. nothum*, Unger, and possibly could perfect specimens of both be obtained, they might prove to be identical. In the mean time however as the scars and leaves of *L. nothum* are unknown, it is difficult to institute a comparison.

5. *Psilophyton princeps*.—mihi.

Great numbers of slender bifurcating stems appear on the shales brought from Perry by Mr. Richardson. They are not well preserved; but it seems scarcely to admit of a doubt, that they belong to this species, so characteristic of the Gaspé sandstones.

6. *Megaphyton*?

A flattened stem two inches in diameter, irregularly ribbed and striated, appears to show a row of scars on the exposed side, as in the above named genus. The scars are not however well defined. The plant has a slender pyritised axis giving off a few bunches or bundles of vessels to the sides. The structure is very imperfect but was possibly scalariform.

7. *Sternbergia*.

In the collection with which I have been favored by the Natural History Society of Portland, is an impression of a *Sternbergia* not distinguishable from that of *Dadoxylon Ouangondianum*, of St. John, to which species it perhaps belonged. It retains no traces of the wood; but casts of *sternbergia* in the same naked condition often occur in the coal measures.

8. *Aporoxylon*.

Many fragments of carbonised wood showing aporous cells occur in the Perry sandstones: I refer them in the mean time to the above genus of Unger.

III. GASPÉ SANDSTONES.

From these rocks I have but one species to notice at present. It is that referred to in my former paper as probably a *Knorria*,*

* Paper on Devonian Plants of Gaspé, Journal of Geological Society, Vol. XV.

but of which I have recently obtained better specimens which induce me to propose for it the name of—

Selaginites formosus.—S. n.

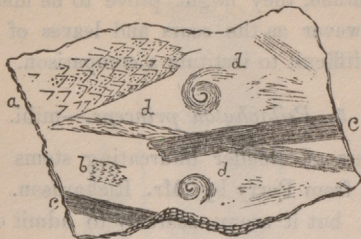


Fig. 11.—Fragment of shale from Gaspé.

(a) *Selaginites formosus*. (b) Smaller specimen of the same. (c) *Cordaites angustifolia*. (d) *Psilophyton princeps*.

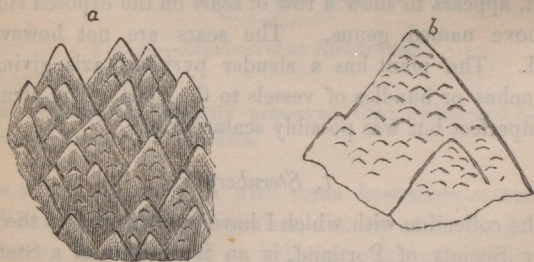


Fig. 12.—*Selaginites formosus*.

(a) Small specimen magnified. (b) Scale of larger specimen magnified.

Description.—Stems covered with flat broad angular imbricating scales of unequal size, and ornamented with minute scaly points.

The original specimen of this curious plant was a fragment of the bark on sandstone in the collection of Sir W. E. Logan. I have since discovered in the bituminous shale overlying the Devonian coal of Gaspé, and which abounds in vegetable fragments, several portions of flattened stems showing the characters more perfectly. The different sizes of the fragments and of the scales that clothe them would indicate that it was a branching or dichotomous plant. Their condition of preservation shows that

the bark was firm and durable. The scales are flat, quite angular and closely appressed, but seem to have been thick, and are evidently free at their extremities and without any indication that they supported leaves. They show no ribs or nervures; but are covered with little subordinate projecting points or scales as shown in the figures.

I formerly referred this plant to *Knorria*, on account of its scaly stem; but this genus has recently been placed in a somewhat equivocal position by Goeppert, * who finding, as I had previously done, † that the plants called *Knorria* in the Lower coal measures, are really decorticated or imperfectly preserved *Lepidodendra* or *Sagenariae*, seems disposed to abandon the genus.

The present species might however still remain as a typical *Knorria* having a scaly stem and quite distinct from *Lepidodendron*, but to avoid any confusion between it and the plants heretofore known as *Knorria* but now ascertained to be of a different character, I prefer to place it in the mean time in *Selaginites*; in the hope that more perfect specimens may soon illustrate more fully its affinities.

CONCLUDING REMARKS

In comparing with each other the plants of the three localities above referred to, it will be observed that they have few species in common. Probably two species are common to Perry and St. John, and two to the former and Gaspé; while it is doubtful if one is found in all three. It must be observed however that according to Mr. Billings, the fossil shells of the Gaspé sandstones indicate a Lower Devonian age, while it is quite probable that the rocks of Perry and St. John may be Upper Devonian; and this is the more likely as the plants of the St. John beds are decidedly nearer in their facies to those of the coal formation than are those of Gaspé.

None of the species found in these old beds have as yet been recognised in the carboniferous system in British America; and only one, *C. transitionis*, elsewhere. The generic types are however the same, with the exception of *Prototaxites* and *Psilophyton*,

* Flora der Silurischen, &c., 1860.

† Paper on Lower Coal measures, Journal of Geological Society, Vol. XV. P. 69.

and possibly also the form of *Cyclopteris* represented by *C. Jacksoni*, which differs from any fern of the coal formation, and is perhaps entitled as Lesquereux maintains to a distinct generic name. The generic assemblage in the beds now under consideration, resembles that in the lower coal formation, and differs from that in the true coal measures, in the prevalence of Lycopodiaceous plants and the comparative absence of Sigillariæ; but the genera *Lepidodendron* and *Sagenaria* so characteristic of the lower coal measures are slenderly represented here. It is also to be observed that the genera *Asterophyllites* and *Sphenophyllum*, though common to the St. John group and the coal measures, are, in so far as known, absent from the lower coal formation in Nova Scotia and New Brunswick. The former genus is however found in the Lower coal in Silesia. It is interesting to observe in the St. John beds which have been disturbed and metamorphosed before the carboniferous period, a generic assemblage so similar to that of the coal. On the other hand it is still more curious to find that the absence of the great Sigillaroid and Ulodendroid trees, so characteristic of the wide swampy flats of the coal period, gives to the St. John flora a more modern aspect than that of the coal; though in its exclusively cryptogamous and gymnospermous character, and in its generic forms, it is quite as decidedly palæozoic.

In comparing the plants in the Devonian of Eastern America with those of Europe, a smaller proportion of identical species appears than in the case of the coal measures. There may have been in the Devonian period a greater geographical separation or climatic difference between the European and American land than in the time of the coal formation. On the other hand, however, a part of the plants ascertained here belong to the Lower Devonian, which has hitherto afforded only one land species in Europe, while here it contains several well preserved species and even a small bed of coal; and with respect to the Upper Devonian the number of known species is too small as yet to admit of a satisfactory comparison.

I trust that the species described in this and my previous paper are but a small instalment of those to be brought to light by further search. In the meantime I present the following summary of these species, as representing the present state of our knowledge. I have introduced those that are doubtful as well as those fully

ascertained; and have arranged them in families according to my present views of their affinities—views which may however admit of important modifications when the plants shall become better known.

Summary of Fossil Plants, from beds older than the Carboniferous system, in British America and Maine.—[Described in this paper; and in that on the Devonian plants of Gaspé, in the Journal of the Geological Society of London, Vol. 15, and Canadian Naturalist, Vol. 5.]

(a).—*Exogenous Gymnosperms.*

1. *Coniferæ.*

- (1.) *Prototaxites Logani*, mihi,.....Lower Devonian, Gaspé.
- (2.) *Dadoxylon Ouangondianum*, m.,.....St. John group.
- (3.) *Sternbergia*, (probably pith of last species), Devonian, Perry.
- (4.) *Aporoxylon*,.....Do.

2. *Sigillariæ.*

- (5.) *Sigillaria?*—*Cyperites?*.....St. John.

(b.)—*Doubtful if Gymnosperms or Cryptogams.*

3. *Calamitæ.*

- (6.) *Calamites transitionis*, Goeppert,.....St. John.

4. *Asterophyllitæ.*

- (7.) *Asterophyllites parvula*, m.,.....St. John.
- (8.) *Sphenophyllum antiquum*, m.,.....St. John.

(c.)—*Acrogenous Cryptogams.*

5. *Lycopodiaceæ.*

- (9.) *Lepidodendron Gaspianum*, m.,.....Gaspé and Perry.
- (10.) *Lepidostrobus Richardsoni*, m.,.....Perry.
- (11.) L.——,.....Perry.
- (12.) *Lycopodites Matthewi*, m.,.....St. John.
- (13.) *Psilophyton princeps*, m.,.....Gaspé, Perry, St. John?
- (14.) P.——— *robustus*, m.,.....Gaspé.
- (15.) *Selaginites formosus*, m.,.....Gaspé.
- (16.) *Megaphyton?*.....Perry.
- (17.) *Cordaite Robbii*, m.,.....St. John.
- (18.) C.——— *angustifolia*, m.,.....St. John and Gaspé.
- (19.) *Sagenaria?* (Knorria).....Devonian, Kettle Point.

6. *Filices.*

- (20.) *Cyclopteris Jacksoni*, m.,.....Perry and St. John.
- (21.) *Sphenopteris*,.....St. John.

Adding to the above the species from the Devonian of New York and Pennsylvania, described in the Reports of the Geology of those states, and in the Memoir of Goeppert above referred to, we may estimate the known land flora older than the carboniferous period in Eastern America, at about thirty species, belonging to at least fifteen genera, all cryptogamous or gymnospermous.

NOTE.—While the above paper was passing through the press, Mr. Mathew and Mr. Hartt have discovered a new locality of fossil plants near the mouth of the harbour of St. John, which has afforded several additional species.

May, 1861.

ON THE
FLORA OF THE DEVONIAN PERIOD
IN
NORTH-EASTERN AMERICA.

BY

J. W. DAWSON, LL.D., F.G.S.,

Principal of M'Gill College, Montreal.

ON THE
FLORA OF THE DEVONIAN PERIOD

NORTH-EASTERN AMERICA.

[PLATES XII.-XVII.]

CONTENTS.

I. Notices of the localities of the Devonian Plants.	
1. State of New York.	3. Canada.
2. Maine.	4. New Brunswick.
II. Descriptions of the species.	
Angiospermous Dicotyledon.	
Exogenous Gymnosperms.	Aerogenous Cryptogams.
Coniferae.	Lycopodiaceae.
Sigillariae.	Filices.
Calamitae.	Incertae sedis.
Asterophyllitae.	Algæ.
	III. Conclusion.

THE existence of several species of land-plants in the Devonian rocks of New York and Pennsylvania was ascertained many years ago by the Geological Surveys of those States, and several of those plants have been described and figured in their Reports*. In Canada Sir W. E. Logan had ascertained, as early as 1843, the presence of an abundant, though apparently monotonous and simple, flora in the

* Hall and Vanuxem, Reports on the Geology of New York; Rogers, Report on Pennsylvania.

constitute an addition to the Devonian Flora equal in importance to all the plants previously obtained from rocks of this age, and establish for some of the species a very extensive distribution both geologically and geographically; they allow, also, more satisfactory comparisons than were heretofore practicable to be instituted between the Devonian Flora and that of the Carboniferous Period.

I shall first shortly notice the geological character of the localities, with lists of the fossils found in each, and shall then proceed to describe the new species.

I. NOTICES OF THE LOCALITIES OF THE DEVONIAN PLANTS.

1. *State of New York*.—The geology of this State has been so fully illustrated by Prof. Hall and his colleagues, and the parallelism of its formations with those of Europe has been so extensively made known by Murchison and others, that it is only necessary for me to state that the fossils entrusted to me by Prof. Hall range from the Marcellus Shale to the Catskill group inclusive, and thus belong to the Middle and Upper Devonian of British geologists. The plants are distributed in the subdivisions of these groups as follows:—

* Quart. Journ. Geol. Soc. vol. xv. p. 477.

† Vol. vii. May 1861.

ERRATA ET CORRIGENDA.

Pages 296-329 inclusive. A delay in the transmission to Dr. Dawson of a proof of his paper having occurred, the Author's corrections were not received until after its publication, and the following list of *Errata* has consequently become necessary:—

- Page 299, line 30, for M'Clakeney's read M'Closkeney's.
 " " line 30, for Cones read Coves.
 " " line 39, for Fort House read Fort Howe.
 " 305, line 8, second column, for *decurrens* read *discrepans*.
 " " line 11, first column, for *Goeppert* read *Lesquereux*.
 " 309, line 26, for *Skaneateles* read *Shenectales*.
 " 310, line 4 from bottom, for specimen read specimens.
 " 313, line 14, for Houghton read Houghton.
 " 314, line 9 from bottom, for *pinnaformis* read *pennaeformis*.
 " " line 7 from bottom, for were read was.
 " 321, line 25, for *Davallioides* read *Davallia*.
 " 323, line 27, for *Rimeriana* read *Romeriana*.
 " 324, line 5, for Mr. Lann read Mr. Lunn.
 " " last line, for *lineata* read *hirsuta*.
 " 325, line 12, for *invested* read *inverted*.
 " 327, Table, No. 57, for *decurrens* read *discrepans*.
 " 329, Description of Plate XIII. fig. 25, for *C. acutum* read *C. obliquum*.
 " " " " XV. fig. 39, for *obtusilobus* read *curtilobus*.
 " " " " " fig. 40, for *decurrens* read *discrepans*.
 (See also the Appendix.)

[PLATES XII.-XVII.]

CONTENTS.

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| <p>I. Notices of the localities of the Devonian Plants.</p> <ol style="list-style-type: none"> 1. State of New York. 2. Maine. <p>II. Descriptions of the species.</p> <p>Angiospermous Dicotyledon.</p> <p>Exogenous Gymnosperms.</p> <p>Coniferae.</p> <p>Sigillariae.</p> <p>Calamitae.</p> <p>Asterophyllitae.</p> | <p>3. Canada.</p> <p>4. New Brunswick.</p>
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Devonian strata of Gaspé; but it was not until 1859 that these plants were described by the author in the 'Proceedings' of this Society*. More recently Messrs. Matthew and Hartt, two young geologists of St. John, New Brunswick, have found a rich and interesting flora in the semi-metamorphic beds in the vicinity of that city, in which a few fossil plants had previously been observed by Dr. Gesner, Dr. Robb, and Mr. Bennett of St. John; but they had not been figured or described. These plants, however, I described in the 'Canadian Naturalist'†, together with some additional species, of the same age, found at Perry, in the State of Maine, and preserved in the collection of the Natural History Society of Portland. The whole of the plants thus described I summed up in the paper last mentioned as consisting of 21 species, belonging to 16 genera, exclusive of genera like *Sternbergia* and *Lepidostrobus*, which represent parts of plants only.

In the past summer I visited St. John; and, in company with Messrs. Matthew and Hartt, explored the localities of the plants previously discovered, and examined the large collections which had been formed by those gentlemen since the publication of my previous paper. The material thus obtained proving unexpectedly copious and interesting, I was desirous of having opportunities of fuller comparison with the Devonian Flora of New York State; and, on application to Prof. Hall, that gentleman, with consent of the Regents of the University of New York, kindly placed in my hands the whole of his collections, embracing many new and remarkable forms. Prof. C. H. Hitchcock, State-geologist of Maine, had in the meantime further explored the deposits at Perry, and has communicated to me three new species discovered by him. The whole of these collections, amounting in all to more than sixty species, constitute an addition to the Devonian Flora equal in importance to all the plants previously obtained from rocks of this age, and establish for some of the species a very extensive distribution both geologically and geographically; they allow, also, more satisfactory comparisons than were heretofore practicable to be instituted between the Devonian Flora and that of the Carboniferous Period.

I shall first shortly notice the geological character of the localities, with lists of the fossils found in each, and shall then proceed to describe the new species.

I. NOTICES OF THE LOCALITIES OF THE DEVONIAN PLANTS.

1. *State of New York*.—The geology of this State has been so fully illustrated by Prof. Hall and his colleagues, and the parallelism of its formations with those of Europe has been so extensively made known by Murchison and others, that it is only necessary for me to state that the fossils entrusted to me by Prof. Hall range from the Marcellus Shale to the Catskill group inclusive, and thus belong to the Middle and Upper Devonian of British geologists. The plants are distributed in the subdivisions of these groups as follows:—

* Quart. Journ. Geol. Soc. vol. xv. p. 477.

† Vol. vii. May 1861.

UPPER DEVONIAN.

Catskill Group.

Aporoxylon.
 Sigillaria Simplicitas, *Vanuxem.*
 Lepidodendron Gaspianum, *Dawson.*
 Psilophyton princeps, *Dawson.*

Cyclopteris Jacksoni, *Dawson.*
 Rhachiopteris punctata, sp. nov.
 — cyclopteroides, sp. nov.

Chemung Group.

Sigillaria Vanuxemii, *Gæppert.*
 Syringodendron gracile, sp. nov.
 Stigmaria exigua, sp. nov.
 Lepidodendron Chemungense, *Hall.*
 — corrugatum, *Dawson.*

Lycopodites Vanuxemii, sp. nov.
 Cyclopteris Halliana, *Gæppert.*
 Psilophyton princeps, *Dawson.*
 Acanthophyton spinosum, sp. nov.
 Rhachiopteris striata, sp. nov.

MIDDLE DEVONIAN.

Hamilton Group.

Syringoxylon mirabile, sp. nov.
 Dadoxylon Hallii, sp. nov.
 Aporoxylon.
 Sigillaria.
 Didymophyllum reniforme, sp. nov.
 Calamites Transitionis (?), *Gæppert.*
 — inornatus, sp. nov.
 Lepidodendron Gaspianum, *Dawson.*
 — corrugatum, *Dawson.*

Psilophyton princeps, *Dawson.*
 Cordaites Robbii (?), *Dawson.*
 —, sp. nov.
 — angustifolia, *Dawson.*
 Cyclopteris incerta, sp. nov.
 Rhachiopteris striata, sp. nov.
 — tenuistriata, sp. nov.
 — pinnata, sp. nov.

2. *Maine.*—The only locality in this State that has hitherto afforded fossil plants is Perry, near Eastport, in the eastern part of the State. The plant-bearing rocks are grey sandstones, resembling those of Gaspé, and associated with red conglomerate and trappean or tuffaceous rocks, which, according to the recent observations of Prof. C. H. Hitchcock*, rest unconformably on shales or slates holding Upper Silurian fossils†. I have little doubt that these beds at Perry are a continuation of part of the series observed at St. John, New Brunswick; and it is probable that they are Upper Devonian. The following species occur at this place:—

Lepidodendron Gaspianum, *Dawson.*
 Lepidostrobus Richardsonii, *Dawson.*
 — globosus, *Dawson.*
 Psilophyton princeps, *Dawson.*
 Leptophloeum rhombicum, sp. nov.

Megaphyton?
 Aporoxylon?
 Cyclopteris Jacksoni, *Dawson.*
 — Brownii, sp. nov.
 Sphenopteris Hitchcockiana, sp. nov.

3. *Canada.*—Devonian beds holding fossil plants occur in Eastern Canada, in Gaspé, and in Western Canada, at Kettle Point, Lake Huron. At the former place there is an extensive series of sandstones and shales, regarded by Sir W. E. Logan as representing the whole of the Devonian series, and containing plants throughout, but

* Report on the Geological Survey of Maine, now in the press.

† See also notices by Dr. Jackson and Prof. Rogers in the 'Proceedings of the Boston Society of Natural History.'

more abundantly in its central portion*. At the latter a few plants have been found in shales of Upper Devonian age. The plants found at Gaspé were described in my former paper, and are—

Prototaxites Logani, Dawson.

Lepidodendron Gaspianum, Dawson.

Psilophyton princeps, Dawson.

Psilophyton robustius, Dawson.

Selaginites formosus, Dawson.

Cordaite angustifolia, Dawson.

The plants from Kettle Point, noticed with doubt in my former paper, I may now refer to the following species:—

Sagenaria Veltheimiana, Gœppert.

Calamites inornatus, sp. nov.

4. *New Brunswick*.—The rocks in the vicinity of the city of St. John, constituting a part of the coast metamorphic series of New Brunswick, have been described in the official reports of Dr. Gesner and Dr. Robb†; and additional facts respecting their stratigraphical relations, ascertained by Mr. Matthew, were stated in my paper in the 'Canadian Naturalist,' already referred to. The new interest attached to these beds, in consequence of the discovery of their copious fossil flora, induced me to re-examine all the sections, in company with Mr. Matthew, during my late visit; and that gentleman has recently extended the limits of our observations eastward in the direction of Mispec. The results of these observations I shall state in some detail, as the precise age of the St. John series has not until now been determined.

The oldest rocks seen in the vicinity of St. John are the so-called syenites and altered slates in the ridges between the city and the Kennebeckasis River. These rocks are in great part gneissose, and are no doubt altered sediments. They are usually of greenish colours; and in places they contain bands of dark slate and reddish felsite, as well as of grey quartzite. In their upper part they alternate with white and graphitic crystalline limestone, which overlies them in thick beds at McClakeney's and Drury's Cones on the Kennebeckasis, and again on the St. John side of an anticlinal formed by the syenitic or gneissose rocks, at the suburb of Portland. These limestones are also well seen in a railway-cutting five miles to the eastward of St. John‡, and at Lily Lake. Near the Kennebeckasis they are unconformably overlain by the Lower Carboniferous conglomerate, which is coarse and of a red colour, and contains numerous fragments of the limestone.

At Portland the crystalline limestone appears in a very thick bed, and constitutes the ridge on which stands Fort House. Its colours are white and grey, with dark graphitic laminæ; and it contains occasional bands of olive-coloured shale. It dips at a very high

* Reports of the Geological Survey of Canada; paper on the Devonian Plants of Gaspé, Quart. Journ. Geol. Soc. vol. xv.

† Gesner's Second and Third Reports on the Geological Survey of New Brunswick; Robb, in Johnston's Report on the Agriculture of New Brunswick.

‡ At this place the limestone is penetrated by a thick vein of graphic granite, holding black tourmaline; and at Drury's Cove, not far distant, it contains dykes of dark-coloured trap.

Fig. 1.—Section taken along the Eastern Side of Courtney Bay, New Brunswick.

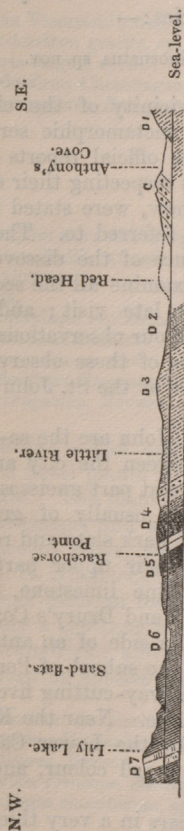
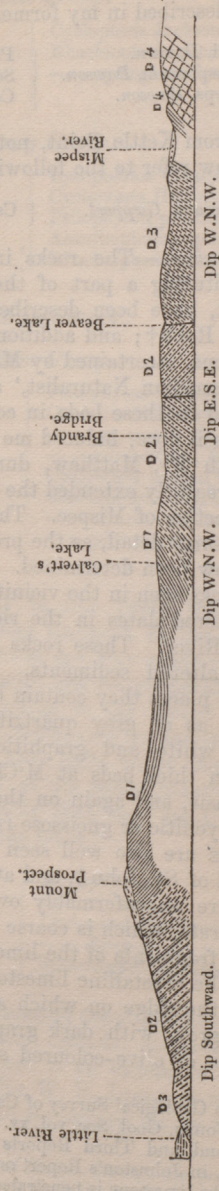


Fig. 2.—Section from the Valley of Little River to Mispec River, New Brunswick.



C. Lower Carboniferous Conglomerate.

D 1. Upper red sandstone and conglomerate of the Devonian Series.

D 2. Second conglomerate, and red and green sandstone and shales of the Devonian Series.

D 3. Conifer-sandstone and plant-beds of the Devonian Series.

D 4. Trappean rock, sandstone, and conglomerate.

D 5. Black papyraceous shale.

D 6. St. John Shales, and Lingula-beds.

D 7. St. John Limestone.

angle to the south-east. Three beds of impure graphite appear in its upper portion. The highest is about a foot in thickness, and rests on a sort of underclay. The middle bed is thinner and less perfectly exposed. The lower bed, in which a shaft has been sunk, seems to be three or four feet in thickness. It is very earthy and pyritous. The great bed of limestone is seen to rest on flinty slate and syenitic gneiss, beneath which, however, there appears a minor bed of limestone. Above the great limestone are beds of a hard grey metamorphic rock, apparently an indurated volcanic ash, associated with some sandstone; and this is succeeded by the great series of grey, olive, and black shales and flags which underlie the city of St. John. These rocks are well exposed on both sides of Courtney Bay, in the city of St. John, and in Carlton. Though somewhat contorted, they have a general dip to the south-east at angles of 50° to 70° . In some of the beds there are great numbers of *Lingule*, which have not as yet been identified with any described species. There are also trails of Worms, and scratches which may have been produced by the feet of Crustaceans or the fins of Fishes.

The comparatively coarse shales above described are succeeded by a thick band of black papyraceous shale, much contorted, and with a few thin seams of calcareous matter arranged in the concretionary form known as cone-in-cone. No fossils were found in them, but two thin seams of anthracitic coaly matter are stated to have been seen on their line of strike eastward of Courtney Bay*.

Overlying these beds is a group of very different character. It consists of purplish-red and green grit and shale, with beds of red conglomerate and red sandstone. Interstratified with these are massive beds of a greenish rock, consisting of trappean and felspathic fragments, imbedded in a shining reddish paste, or sometimes presenting the appearance of a compact trap or amygdaloid. This rock usually presents an appearance of greater alteration than the neighbouring beds, and contains veins of epidote, quartz, and calc-spar. Its hard and massive character causes it to resist denudation, and to project above the surface in irregular masses. It has usually been regarded as a trap; I am disposed, however, to consider it as more probably a tufaceous or volcanic ash rock, except in a few places, where it is either an amygdaloidal trap or a mass of fragments of such material too intimately connected to be separated from each other. It is evidently a stratified member of the series, though its beds are very unequal in hardness and texture, and probably also in thickness. This portion of the series is well exposed on the east side of Courtney Bay, in the southern part of the city of St. John, and in the direction of Carlton, where its tufaceous or trappean members constitute prominent elevations. It seems also to be this member of the series which, turning to the south, constitutes Cape Meogenes.

Reposing on the rocks last described is the most interesting member of the series, consisting of hard buff and grey sandstones, with black and dark-grey shales. The sandstones contain numerous Coniferous trunks; and the shales, which are sometimes highly

* Gesner's Second Report.

graphitic, abound in delicate vegetable remains, often in a very perfect state of preservation. These rocks appear on the east side of Courtney Bay, near Little River, at the extremity of the point of land on which the city of St. John stands, and in the ledges and cliffs on the shore westward of Carlton. In all these places they are quite conformable with the underlying rocks, though the dip gradually diminishes in ascending.

No rocks newer than the above are seen at Carlton or in the city of St. John; but near Little River a few beds of red shale and coarse sandstone seem to indicate the commencement of a new member of the series, the coast-section failing at this point. Mr. Matthew has, however, succeeded in finding a continuation of the section further inland, exhibiting first, in ascending order, grey sandstone and grit, with dark shale holding fossil plants, among which is *Calamites Transitionis*. This may perhaps be regarded as the top of the group last mentioned. Above it, and passing into it at their base, are reddish sandstones, grits, and conglomerate, alternating with green, greenish-grey, and red shale. Resting on these is a thick-bedded, coarse, angular conglomerate, succeeded by evenly bedded shales, shaly sandstones, and grits, of dark-red and purplish colours. These are the highest beds seen, as beyond this place they are bent in a synclinal, and reappear with reversed dips.

Another most important observation of Mr. Matthew is that near Red Head the member of the St. John series last described is overlain unconformably by a conglomerate similar to that of the Kennebeckasis, and probably the Lower Carboniferous conglomerate. It dips to the north-west, or in the opposite direction from that of the underlying beds, at an angle of 30° ; but Mr. Matthew regards the dip as due in part to false bedding.

The whole of the deposits above described may be summed up as follows, the thicknesses stated being from measurements and estimates made by Mr. Matthew, and to be regarded as merely approximate* (see figs. 1 & 2).

Carboniferous System.

Coarse red conglomerate, with pebbles of the underlying rocks, Feet.
and constituting in this vicinity the base of the Carboniferous System.

Devonian System (or perhaps, in part, Upper Silurian).

1. Dark-red and greenish shales; flaggy sandstones and grits;
coarse angular conglomerate 1850

* In my paper in the 'Canadian Naturalist,' I gave a sectional view of the general arrangement, as observed on a line of section from the Kennebeckasis River to the extremity of the peninsula on which St. John stands. The sections referred to in the text represent the same series, as seen on the east side of Courtney Bay, immediately to the east of St. John, with the continuation ascertained by Mr. Matthew towards the Mispic River.

- | | |
|--|--------------------|
| 2. Reddish conglomerate, with quartz pebbles; reddish, purple, and grey sandstones and grits; deep-red, grey, and pale-green shales. A few fossil plants | Feet.
2350 |
| 3. Blackish and grey hard shale and arenaceous shale; buff and grey sandstone and flags. Many fossil Plants; Crustaceans and <i>Spirorbis</i> | 2000 |
| 4. Reddish conglomerate, with slaty paste and rounded pebbles; trappean or tufaceous rock; red, purplish, and green sandstones and shales. Thickness variable | 1000 |
| 5. Black papyraceous shale, with layers of cone-in-cone concretions | 400 |
| 6. Hard, generally coarse and micaceous, grey shales and flags, of various shades of colour, and with some reddish shale and tufaceous or trappean matter at the bottom. <i>Lingula</i> , Burrows, and Trails of animals | 3000 feet or more. |
| 7. White and grey crystalline limestone, with bands of shale and beds of graphite | 600 feet or more. |
| 8. Gneissose and other metamorphic beds, with bands of quartz-rock and slate. Thickness unknown. | |

The Devonian age of the upper members of this great series of beds I regard as established by their fossils*, taken in connexion with the unconformable superposition of the Lower Carboniferous conglomerate. The age of the lower members is less certain. They may either represent the Middle and Lower Devonian, or may be in part of Silurian age. Their only determinable fossil, the *Lingula* of the St. John shales, affords no decisive solution of this question, and the evidence of mineral character is not to be relied on in the case of beds so remote from those regions in which the Devonian rocks of America have been most minutely studied.

In mineral character, Nos. 1 & 2 of the above sectional list might very well represent the Old Red Sandstone, or Catskill group of the New York geologists. Nos. 3 & 4 might be regarded as the analogues of the Chemung and Portage groups. No. 5 would represent the Genesee Slate; No. 6 the remainder of the Hamilton group; No. 7 the Corniferous Limestone; and No. 8 might be regarded as a metamorphosed equivalent of the Oriskany and Schoharie Sandstones. The entire want of the rich marine fauna of these formations is, however, a serious objection to this parallelism. If, on the other hand, we employ as our scale of comparison the development of the Devonian system in Gaspé, Nos. 1 & 2 will correspond very well with the upper member of the Gaspé series, and No. 3 with the rich plant-bearing beds of the middle of that series; but no mineral

* The scanty animal remains of the plant-beds No. 3 accord very well with the evidence of the fossil Plants. They are a small Trilobite, apparently a *Philipsia*, three other Crustaceans, one of which is probably a *Stylonurus*, another a *Eurypterus*, and the third a Decapod not apparently referable to any described genus. These Crustaceans are now in the hands of Mr. Salter. (See his paper on these fossils, read before the Society, May 21, 1862.) There is also a shell, apparently a *Loxonema*, and a *Spirorbis*.

equivalent of the St. John shales and limestones occurs at Gaspé, unless we seek for it in the Upper Silurian.

The rocks of the St. John group extend along the coast as far as the frontier of Maine, and there can scarcely be any doubt that the plant-bearing beds at Perry represent some portion of the St. John series, most probably Nos. 2 & 3 of our sectional list. At Perry the plant-beds rest on a trappean bed, which may be the equivalent of our No. 4, a member of the series much more constant in its occurrence than would be anticipated from its composition. According to Prof. Hitchcock, this last bed at Perry rests unconformably on shales containing a *Lingula* which may be identical with that of St. John, and also other fossils of distinct Upper Silurian forms. The analogy of Perry, therefore, as well as of Gaspé, would point to an Upper Silurian age for the lower members of the St. John series, though at St. John they appear to be conformable with the overlying beds. On the other hand, the unconformability at Perry renders it possible that the lower members of the St. John series may be wanting there; and to assign a Silurian date to the lower beds at St. John would imply the entire absence of the copious and characteristic Lower Devonian marine fauna observed at Gaspé and in Nova Scotia, as well as in Maine, though not in immediate connexion with the Perry beds; while, if the whole series of St. John be Devonian, the absence of this fauna would be accounted for by the metamorphism of the lower beds.

In the present state of the evidence, it would be premature to decide this question, which may be settled either by the discovery of portions of the lower beds in a less altered state, or by tracing the St. John series into connexion with the similar deposits in Maine. In the meantime, therefore, we may be content to regard the upper members of the series as belonging to the later part of the Devonian Period, leaving the lower members to be regarded as Lower Devonian or possibly Upper Silurian.

The fossiliferous portion of the St. John series presents the richest local flora of the Devonian Period ever discovered. It far excels, in number of genera and species, the Lower Carboniferous flora as it exists in British America, and is comparable with that of the Middle Coal-measures, from which, however, it differs very remarkably in the relative development of different genera, as well as in the species representing those genera.

It is only just to observe, that the completeness of the following list is due to the industrious labours of an association of young gentlemen of St. John, who, under the guidance of Messrs. Matthew and Hartt, have diligently explored every accessible spot within some distance of the city, and have liberally placed their collections at my disposal for the purposes of this paper.

Dadoxylon Ouangondianum, Dawson.

Sigillaria palpebra, sp. nov.

Stigmara ficoides (var.), Brongn.

Calamites transitionis, Göppert.

— *cannæformis*, Brongn.

Asterophyllites acicularis, sp. nov.

— *latifolia*, sp. nov.

— *scutigera*, sp. nov.

— *longifolia*, Brongn.

— *parvula*, Dawson.

- | | |
|----------------------------------|---------------------------------------|
| Annularia acuminata, sp. nov. | Sphenopteris Hoeninghausi, Brongn. |
| Sphenophyllum antiquum, Dawson. | — marginata, sp. nov. |
| Pinnularia dispalans, sp. nov. | — Hartii, sp. nov. |
| Lepidodendron Gaspianum, Dawson. | — Hitchcockiana, sp. nov. |
| Lycopodites Matthewi, Dawson. | Hymenophyllites Gersdorffii, Gæppert. |
| Psilophyton elegans, sp. nov. | — obtusilobus, Gæppert. |
| — glabrum, sp. nov. | — curtilobus, sp. nov. |
| Cordaites Robbii, Dawson. | Pecopteris (Alethopteris) decurrens, |
| — angustifolia, Dawson. | sp. nov. |
| Cyclopteris Jacksoni, Dawson. | — (—) ingens, sp. nov. |
| — obtusa, Gæppert. | — (—) obscura (?), Lesquereux. |
| — varia, sp. nov. | Trichomanites, sp. nov. |
| — valida, sp. nov. | Cardiocarpum cornutum, sp. nov. |
| Neuropteris serrulata, sp. nov. | — obliquum, sp. nov. |
| — polymorpha, sp. nov. | Trigonocarpum racemosum, sp. nov. |

II. DESCRIPTIONS OF THE SPECIES.

(Angiospermous Dicotyledon.)

1. SYRINGOXYLON MIRABILE, gen. et sp. nov. Pl. XII. figs. 1 to 5.

Woody tissue close, thick-walled. Ducts many times the diameter of the wood-cells, thin-walled, with transverse pores in several series. Medullary rays of two or more series of muriform cells. Growth-rings distinct.

This genus and species are founded on a small fragment of wood, mineralized by carbonate of lime, silica, and iron-pyrites. It is evidently the wood of an angiospermous exogen, and does not differ materially from that of some modern trees. It is, in so far as I am aware, the first instance of such wood in Palæozoic rocks, and would imply the existence in the Devonian Period of trees of a higher grade than any that are known in the Carboniferous System. This fact is not, however, in itself more remarkable than the occurrence of a single Land-snail in the Coal-formation, more especially when we consider the perishable character of the wood of angiosperms as compared with that of gymnosperms and cryptogams, and the small amount of attention usually bestowed by geologists on fragments of mineralized wood. It is also to be remarked that, as I have elsewhere had occasion to note, the Devonian flora has in other points a more modern aspect than that of the Coal—a circumstance which may perhaps relate to a different distribution of land and water, and to the comparative absence of the wide inundated flats of the Coal-period. It may, however, merely result from the unequal and fortuitous preservation of some descriptions of plants rather than others in the beds of one or both of these periods.

The specimen is labelled as from Eighteen-mile Creek on Lake Erie, and was collected several years ago by Prof. Hall from a limestone in the upper part of the Hamilton group. It has unfortunately no matrix attached to it; but Prof. Hall assures me that he has no reason to doubt its genuineness.

(Exogenous Gymnosperms.)

(Coniferae.)

2. DADOXYLON (ARAUCARITES) OUANGONDIANUM, Dawson.

'Canad. Naturalist,' vol. vi. pp. 165, 166, figs. 1 to 4.

"Branching trunks, with distinct zones of growth, and a pith of the Sternbergia type. Wood-cells very large, with three to five rows of contiguous, alternate, hexagonal areoles with oval pores. Medullary rays with one to three series of cells, and as many as 14 rows of cells superimposed on each other*."

In sandstone at St. John, where many large trunks occur, calcified and silicified, and in part converted into anthracite and graphite†. My specimens are from the collection of Mr. Matthew, and are described at length and figured in the paper referred to in the footnote. I have no doubt that this is the Coniferous tree referred to by Dr. Gesner, 'Second Report,' p. 12.

3. DADOXYLON HALLII, sp. nov. Pl. XIII. fig. 11.

Wood-cells very large, with five rows of contiguous, alternate, hexagonal areoles. Medullary rays very frequent, and with as many as thirty rows of cells superimposed.

This species occurs in a pyritized state at Hemlock Creek, Ontario County, New York, in beds of the Hamilton group. It resembles *D. Ouangondianum* in the great size of the wood-cells and the numerous rows of areoles, but differs so markedly in the development of the medullary rays that I regard it as certainly belonging to a distinct species. The specimen, being completely pyritized, can be examined only as an opaque object, so that some of the details of its structure cannot be made out; but the forms of the wood-cells and their areoles, and of the medullary rays, are so beautifully modelled in pyrites that no uncertainty exists as to the points of structure above specified. I have dedicated this species to Prof. Hall, its discoverer.

4. APOROXYLON.

Among Prof. Hall's specimens is one, from Seneca Lake, which may possibly be allied to the plant on which Unger has founded the genus above named. It is a flattened pyritized stem or branch, one inch and a quarter in breadth at the larger end, and slightly tapering, and ten inches in length. It is marked with spirally arranged distant scars, as if of excurrent branches; and it seems to have been woody, with a thin bark and a large pith. The wood is imperfectly

* In the case of this and other species described in my paper on the Pre-carboniferous Flora of New Brunswick, I shall copy in this paper the specific characters merely, referring for fuller descriptions to my paper in the 'Canadian Naturalist,' vol. vi. pp. 161 *et seq.*

† This and other fossil plants found at St. John afford remarkable examples of the conversion of vegetable matter into graphite, without loss of its form or even of its internal structure.

preserved, but shows slender cylindrical fibres destitute of markings, and with mere traces of medullary rays. The general arrangement of parts resembles that in *Prototaxites*, but the markings on the cell-walls are absent. I regard it as quite possible that this may merely be wood of *Dadoxylon* or *Prototaxites*, in which casts of the interior cavities of the cells may have been taken in pyrites, while the cell-walls and medullary rays have been destroyed, and the spaces occupied by them partially obliterated by pressure. Whatever its precise character, it must have been an excurrent stem with many small branches proceeding from it, in the manner of ordinary coniferous trees*.

In the collections made by Mr. Richardson (of the Canadian Geological Survey) at Perry are fragments of stems or branches having a structure somewhat similar to that above described, but still more imperfectly preserved.

(*Sigillaria*.)

5. *SIGILLARIA PALPEBRA*, sp. nov. Pl. XIII. fig. 12.

Ribs narrow, about a quarter of an inch in width. Leaf-scars transversely acuminate, small.

My only specimen is a small fragment, showing three or four ribs, and with only a few of the scars preserved. The most perfect leaf-scars are shaped much like a half-closed eye; but the specimen is only a cast, and very imperfect. Locality, St. John.

6. *SIGILLARIA VANUXEMII*, Gœppert. Pl. XII. fig. 7.

Hall's 'Report Geol. New York,' p. 184, fig. 51; Gœppert's 'Flora Silurisch,' p. 546.

Areoles hexagonal, rather longer than broad. Vascular scars indistinct, apparently two in each areole. Bark thick. Ligneous surface obscurely ribbed, with small elongated scars in the furrows. Woody axis sulcated longitudinally; its diameter equal to one-fourth that of the stem. There are about twelve rows of areoles on a stem half an inch in diameter.

This beautiful little *Sigillaria* is figured, but not named nor described, in Vanuxem's 'Report on the Geology of New York,' fig. 51, p. 184. It is named and described by Gœppert from Vanuxem's figure†. An examination of the original specimen—a sandstone-cast six inches in length, imbedded among brachiopodous shells—enables me to give the above more complete description. The bark is in a coaly state, and the woody axis, though flattened, is quite manifest, and still retains some carbonaceous matter, though destitute of structure. The plant must have been of slender growth, unless it were a branching species. It approaches *S. minima* of Brongniart, but is smaller and not ribbed; in which last respect it resembles *S. ele-*

* Similar stems, more nearly resembling those described by Unger in external form, occur in the Catskill group.

† 'Flora der Silurischen,' &c. p. 546.

gans, of which it may be regarded as a diminutive Devonian prototype.

Its locality is Allen's quarry, near Oswego, and the formation is the Chemung group.

7. *SIGILLARIA SIMPLICITAS*, Vanuxem.

Vanuxem's 'Report Geol. New York,' p. 190, fig. 54.

Ligneous surface with narrow, slightly rugose elevated ribs, about a quarter of an inch wide, in a stem five inches in diameter. Leaf-scars indistinct.

Under the above name Vanuxem has figured a *Sigillaria*, the only specimen of which is a portion of a decorticated stem, with only scarcely distinguishable traces of the leaf-scars. It is from the Catskill group, between Mount Upton and N. Bainbridge.

In Prof. Hall's collection there is a specimen in a similar condition, with wider ribs, and which may have belonged to another species, though it is possibly a part of an older stem of the above. It is from the Hamilton group, shore of Lake Erie, near Buffalo*.

8. *SYRINGODENDRON GRACILE*, sp. nov. Pl. XIII. fig. 14.

Ribs about a line in breadth, with elevated elongated areoles, each with three punctiform vascular scars in a vertical line. Areoles three-eighths of an inch distant vertically. Bark marked with delicate striae converging toward the areoles. On the inner surface of the bark are fine longitudinal and transverse striae, and the scars appear as elongate depressions.

This species is described from a small fragment of the bark in a slab from the Hamilton group of Akron, Ohio, in the collection of Prof. Hall. It resembles in some respects *S. pachyderma*, but is smaller and has thinner bark and more elongated areoles. On the same slab are *Cyperites*, which may have been the leaves of this plant, fragments of stipes of Ferns, and branchlets of *Psilophyton*.

9. *STIGMARIA EXIGUA*, sp. nov. Pl. XIII. fig. 13.

Scars small, in depressed spaces, six in an inch vertically. Stem cylindrical, an inch in diameter.

This diminutive *Stigmaria* was probably the root of one of the slender Sigillaroid trees above described. It is evidently quite distinct from *Stigmaria minuta*, Lesquereux, which is, however, a similar species of nearly as great age. Like many others of the Devonian plants from New York, it occurs in a marine bed; and the

* Some obscurely marked fragments in my collection, from Gaspé and St. John, appear to indicate the existence of a species with wider ribs than the above. Neither Vanuxem's specimens nor these are sufficiently perfect to admit of description; and the somewhat singular name which I have quoted from him may therefore be taken as representing one or more species of *Sigillaria* imperfectly known.

cylindrical cavity within the bark has been filled with sand and the stems of a small branching Coral, which may perhaps have grown within the hollow bark, which in this case, as in that of the *Stigmara* of the Coal-measures, seems to have been almost indestructible. The specimen is from the Chemung group, at Elmira, New York.

10. *STIGMARIA FICOIDES* (variety), Brongniart.

Large roots of *Stigmara*, in some instances with rootlets attached, occur, though rarely, in the sandstone or arenaceous shale near St. John—only two or three specimens having been found. They are not distinguishable from some varieties of the *Stigmara ficoides* of the Coal-measures.

11. *DIDYMOPHYLLUM RENIFORME*, sp. nov. Pl. XIII. fig. 15.

Areoles prominent, spirally arranged, reniform; each resembling a pair of small Stigmaroid areoles attached to each other. Areoles $\frac{1}{10}$ th of an inch in transverse diameter, and about $\frac{1}{4}$ th of an inch distant transversely, and $\frac{3}{8}$ ths vertically, in a stem $\frac{3}{4}$ ths of an inch in diameter.

The genus *Didymophyllum* was established by Gœppert for a plant of the Lower Carboniferous series of Silesia, resembling *Stigmara*, but with double rootlets. The present plant, though specifically distinct, comes fairly within the characters of the genus. I believe it to have been a slender Stigmaroid root or rhizome, sending out its rootlets in pairs instead of singly. It occurs as a cast with the thin coaly bark in part preserved, and is from the Hamilton group, near Skaneateles Lake, New York. A flattened specimen, apparently of the same species, occurs on a slab from the Marcellus Shale. Both are in Prof. Hall's collection.

(*Calamiteæ**)

12. *CALAMITES TRANSITIONIS*, Gœppert.

'Canad. Nat.' vol. vi. p. 168, fig. 5.

This species, so characteristic, according to Gœppert, of the Upper Devonian and Lower Carboniferous series in Europe, is abundant at St. John, both in the sandstone containing Coniferous trees, and the shales which afford Ferns, *Cordaites*, &c. Some of the beds of the latter are filled with flattened stems. This was one of the first fossils recognized in the St. John rocks, specimens having been shown to me in 1857 by the late Prof. Robb†.

A small specimen in Prof. Hall's collection, from the Hamilton group, may possibly belong to this species, though proportionally some-

* In placing the *Calamites* here, I do not mean to affirm that all the plants usually included in that genus are gymnospermous; but I believe that many of them are.

† Dr. Gesner mentions ('Second Report', 1840, p. 12) a *Calamite* (probably this species) as occurring near Little River.

what wider in its ribs. Being only a part of a single internode, it cannot be certainly determined, though it appears at least to indicate the presence of a species of *Calamites* in that group.

13. *CALAMITES CANNÆFORMIS*, Brongniart.

This species, presenting the characters which it exhibits in the Coal-measures, occurs in the ledges west of Carlton, associated with the last species, but in much less abundance. It is a widely distributed species, but has not, I believe, been found previously in rocks older than the Lower Carboniferous.

14. *CALAMITES INORNATUS*, sp. nov. Pl. XVII. fig. 56.

Ribs continuous, as in C. Transitionis, but flat and broad, the breadth of each being a quarter of an inch in a stem four inches in diameter. Nodes distinct, prominent in the flattened stem, owing to their greater density as compared with the internodes.

This species is allied to *C. Transitionis*, but has much wider ribs. It was a woody plant, as, when flattened, a stem four inches in diameter affords a film of compact coal about a line in thickness, which is quite as much as a *Sigillaria* or even a Conifer of the same size would yield under similar circumstances. It much resembles Gœppert's figure of *C. variolatus*, but wants the stigmata said to be characteristic of that species,—instead of which, it has, in the coaly matter representing the stem, numerous irregularly disposed round spots surrounded by concentric circles; but these are evidently concretionary, and of the same nature with the beautiful concentric concretions which appear in some specimens of cherry-coal and of albertite.

The specimen above described is in Prof. Hall's collection from the Genesee slate, from the shore of Cayuga Lake. A comparison of this specimen with the obscure Calamite-like fossils from Kettle Point, Lake Huron, in the collection of the Canadian Survey, referred to in my former paper, satisfies me that they probably belong to the same species.

(*Asterophyllitæ*.)

15. *ASTEROPHYLLITES ACICULARIS*, sp. nov. Pl. XIII. fig. 16.

Stems slender, striated, thickened at the nodes, leafy. Leaves one-nerved, linear, slightly arcuate, ten to fifteen in a whorl, longer than the internodes. Length of leaves one-half to three-fourths of an inch.

This plant is abundant in some layers of shale near St. John. It resembles *A. foliosa*, L. & H., but the leaves are longer, less curved, and more numerous in a whorl. Some of the specimens show that the stem was leafy, as well as the branches; and I have a specimen, apparently the termination of a main stem, showing the whorls of leaves diminishing in size toward the apex. My specimen of this and the following species of *Asterophyllites* are from the collections of Messrs. Matthew and Hartt, and were obtained from the ledges and cliffs west of Carlton.

16. ASTEROPHYLLITES LATIFOLIA, sp. nov. Pl. XIII. fig. 17.

Stem somewhat slender, with enlarged nodes. Leaves oblong-lanceolate, about thirteen in a whorl, one-nerved, longer than the internodes. Length of leaves varying from one-fourth of an inch, near the ends of branches, to an inch or more.

This species abounds in the same locality with the preceding, and is often very perfectly preserved. It has some resemblance to *A. galioides*, L. & H., and to *A. fertilis*, Sternberg; but it differs from the former in the number and form of the leaves, and from the latter in the acuteness of their points.

17. ASTEROPHYLLITES? SCUTIGERA, sp. nov. Pl. XIII. figs. 18, 19, 20.

Stems simple, elongated, attaining a diameter of half an inch, obscurely striated; bearing on the nodes whorls of round or oval scales, or flattened nutlets, which at the ends of the stems are crowded into a sort of spike, while on other parts of the stems the nodes are sometimes an inch apart.

This is a plant of uncertain nature, which I place only conjecturally in this genus. The stems, which are very long, may have been horizontal or immersed, and the apparent scales may either have constituted a sort of sheath, as in *A. coronata*, Unger, or may have been seeds or nutlets flattened like the rest of the plant. Near some of the specimens are fragments of linear leaves, which may have belonged to this plant, though I have not found them attached. When flattened obliquely, the stems appear as rows of circular marks, which represent the harder tissue of the nodes, and have a very singular appearance. This plant, though found with the preceding, does not occur in the layers which contain the other plants; and this may possibly mark a difference of habitat.

18. ASTEROPHYLLITES LONGIFOLIA, Brongniart.

In the shales containing the preceding species are some fragments of an *Asterophyllites* with slender stems, internodes about an inch in length, and linear leaves two or three inches in length, and about 6 to 8 in a whorl. It may belong to the species here named; but the remains are not sufficiently distinct to render this certain.

19. ASTEROPHYLLITES PARVULA, Dawson.

'Canad. Nat.' vol. vi. p. 168, figs. 6a, b, c.

"Branchlets slender. Leaves 5 or 6 in a whorl, subulate, curving upward, half a line to a line long. Internodes equal to the length of the leaves or less. Stems ribbed, with scars of verticillate branchlets at the nodes."

This diminutive species was originally found by Mr. Matthew in the graphitic shale, associated with the conifer-sandstone, at the southern part of the city of St. John. Small fragments of it have subsequently been obtained from the shales of Carlton.

20. ANNULARIA ACUMINATA, sp. nov. Pl. XIII. fig. 21.

Leaves oblong, acuminate, one-nerved, 6 to 9 in a whorl, erect or slightly spreading. Whorls usually found disconnected.

Detached whorls of this species occur, though rarely, on the surfaces of the shales of Carlton. It seems to be a plant of the same type with *A. sphenophylloides*, Unger, which, according to Lesquereux, occurs in the Coal-formation of Pennsylvania.

21. SPHENOPHYLLUM ANTIQUUM, Dawson.

'Canad. Nat.' vol. vi. p. 170, fig. 7.

"Leaflets cuneate, one-eighth of an inch wide at the apex, and less than one-fourth of an inch long. Nerves three, bifurcating equally near the base, the divisions terminating at the apices of six obtuse, acuminate teeth." About 8 leaves in a whorl.

This plant was described from a few detached leaflets from the graphitic shale of St. John, which preserved their form and venation in the most wonderful perfection, though they were completely changed into films of shining graphite. I have since obtained from Mr. Hartt a specimen found at Carlton, which, though the individual leaflets are more indistinct, shows their general arrangement in whorls of 8 or 9 on a slender stem. It is a beautifully symmetrical little plant, quite distinct from any of the species in the Coal-measures.

22. PINNULARIA DISPALANS, sp. nov. Pl. XIII. fig. 22.

Smooth slender stems, producing nearly at right angles long branchlets, some of which produce secondary branchlets in a pinnate manner. Stem and branches having a slender vascular axis.

This plant was not very dissimilar from some common forms of Carboniferous *Pinnularia*. Its main stem must once have been cylindrical, and had a delicate central axis, now marked by a darker line of graphite in the flattened specimens. The branches were not given off in one plane, and also show traces of an axis. There are indications that the stems grew in bundles or groups. It was probably, as has usually been supposed in the case of the species in the Coal-formation, an aquatic root or submerged stem of an *Asterophyllites* or some similar plant.

(*Acrogenous Cryptogams.*)

(*Lycopodiaceæ.*)

23. LEPIDODENDRON GASPIANUM, Dawson. Pl. XIV. figs. 26, 27, 28; and Pl. XVII. fig. 58.

Dawson, Quart. Journ. Geol. Soc. vol. xv. p. 483, figs. 3 a-3 d.

This species, originally discovered in Gaspé, and described in my paper* on the plants of that locality, was afterwards recognized among the fossils from Perry, and more recently at St. John; and numerous and beautiful specimens are contained in Prof. Hall's

* Quart. Journ. Geol. Soc. vol. xv. p. 483.

collections from New York State, where the species occurs in the base of the Catskill group and in the upper part of the Hamilton group. The varied aspects of the species presented in the numerous specimens thus submitted to me would, with a less perfect suite of examples, afford grounds for specific or even generic distinctions. Flattened specimens, covered with bark, present contiguous, elliptical, slightly elevated areoles, with an indistinct vertical line and a small central vascular scar (fig. 58). Decorticated specimens, slightly compressed, show elliptical depressed areoles, not contiguous, and with only traces of the vascular scars (fig. 26). In more slender branches the areoles are often elevated at one end in the manner of a *Knorria* (fig. 28); and in some specimens the areoles are indistinct, and the vascular scars appear as circular spots, giving the appearance presented by the plants named *Cyclostigma* by Houghton (fig. 27). All these forms are, however, merely different states of preservation of the same species.

This plant is closely allied to *L. nothum*, Unger, but differs in its habit of growth and in the size of the areoles relatively to that of the branches. The branches were long and slender, bifurcating rarely, and, unless they were very woody, must have been pendent or decumbent. No large trunks have been seen. It was a widely distributed and abundant species in the Upper and Middle Devonian Periods. The plant figured by Prof. Rogers in the 'Report on Pennsylvania,' p. 829, fig. 677, can scarcely belong to any other than this species; and it is also figured in Vanuxem's 'Report on New York,' p. 191, fig. 55, and p. 157, fig. 38.

24. *LEPIDODENDRON CHEMUNGENSE*, Hall.

Hall's 'Report Geol. New York,' p. 275, fig. 127.

Decorticated stem covered with oval, acuminate, scale-like areoles, more acute and smaller in proportion to the size of the stem than in L. Gaspianum.

The only specimen I have seen is a curved branch, very well figured in Prof. Hall's 'Report on the Geology of New York,' p. 275, fig. 127. It is a *Knorria* state of a *Lepidodendron* or *Sagenaria*, of more robust growth than *L. Gaspianum*, but with smaller areoles. It much resembles a decorticated branch of *L. elegans* of the Lower Coal. Gœppert includes it in his protean species *Sagenaria Veltheimiana*, but it does not correspond precisely with any of the forms figured by him. I think it best, therefore, to retain Prof. Hall's specific name, until better specimens shall enable a satisfactory comparison to be made. Its locality is Elmira, New York, and its geological position is the Chemung group.

25. *LEPIDODENDRON CORRUGATUM*, Dawson. Pl. XII. fig. 10.

Dawson, Quart. Journ. Geol. Soc. vol. xv. p. 68, fig. 2.

Areoles elliptical, distant, and separated by a flat surface of corrugated bark. Vascular scar central, oval, or linear.

In Prof. Hall's collection are specimens from the Chemung and

Hamilton groups, from Akron, Ohio, which I cannot distinguish from the above species, first recognized by me in the Lower Coal-measures of Nova Scotia, and noticed in my paper on the "Lower Carboniferous Coal-measures of British America," Quart. Journ. Geol. Soc. 1858, vol. xv. p. 68. *L. corrugatum*, like other *Lepidodendra*, presents many varieties of growth and preservation; but Prof. Hall's specimens are quite undistinguishable from some of those in my cabinet from the Lower Coal-measures of Horton, Nova Scotia.

26. *LEPIDOSTROBUS RICHARDSONI*, Dawson.

'Canad. Nat.' vol. vi. p. 174, fig. 10.

"Axis not distinctly preserved; form cylindrical(?); scales oblong, with an obscure midrib." From Perry, Maine.

27. *LEPIDOSTROBUS GLOBOSUS*, Dawson.

Round or roundish oval, covered with obscure pointed scales.

This and the preceding are very distinct but puzzling objects, collected by Mr. Richardson at Perry, and are probably the fructification of *Lepidodendra* or allied plants.

28. *LYCOPODITES MATTHEWI*, Dawson.

'Canad. Nat.' vol. vi. p. 171, fig. 8.

"Leaflets one-veined, narrowly ovate-acuminate, one-tenth to one-fourth of an inch in length, somewhat loosely placed on a very slender stem, apparently in a pentastichous manner."

This species was described from specimens found by Mr. Matthew in the graphitic shale in the city of St. John. Somewhat larger specimens have since been obtained from the same bed; but I have not seen the plant elsewhere.

29. *LYCOPODITES VANUXEMII*, sp. nov. Pl. XVII. fig. 57.

Hall's 'Report on the Geology of New York,' p. 273, fig. 125; Vanuxem's 'Report, Geol. New York,' p. 175, fig. 46.

Stem slender. Leaves pinnate, contiguous, linear, about half an inch in length.

This plant appears as graceful, feathered stems, apparently growing in groups. It seems to be very closely allied to *L. pinnaformis*, Göppert, differing chiefly in its more slender stem and shorter pinnales. Still it is very doubtful if it were really a Lycopodiaceous plant. Its leaves were certainly in one plane, and some of the specimens show that they were flattened horizontally, like the filaments of a feather. It may have been related to Ferns rather than to Lycopodiaceæ. It occurs in the Chemung group, at Ithaca, New York. It is well figured in Hall's 'Report,' p. 273, fig. 125, and in Vanuxem's 'Report,' p. 175, fig. 46.

30. *PSILOPHYTON PRINCEPS*, Dawson.

Quart. Journ. Geol. Soc. vol. xv. p. 479, figs. 1 a to 1 i.

This remarkable plant, so characteristic of the whole Devonian system at Gaspé, filling many beds with its rhizomes, in the manner of the *Stigmaria* of the Coal-measures, and preserved in such abundance and perfection that it is much better known to us in its form, structure, and habit of growth than any other plant of the period, proves, as might have been anticipated, to have had a wide distribution in space as well as in time. Fragments of its stems are distinguishable in the sandstones of Perry, and numerous fine specimens occur among the plants from New York State committed to me by Prof. Hall. It occurs in the Hamilton group at Schoharie, New York, and at Akron, Ohio, in the Chemung group at Cascade Falls, and in the Catskill group at Jefferson. Most of the specimens are stems, which show the habit of growth very perfectly. They confirm my inference from the structure of the Gaspé specimens that the plant was woody and rigid, as they often do not lie in one plane, but extend upward and downward in the manner of firm branches buried in sand. Most of the New York specimens seem to have been drifted; but groups of rhizomes, possibly *in situ*, occur in argillaceous sandstone from Fullenham, Schoharie, and in similar beds at Cazenovia and Cascade Falls. These are the only instances presented by Prof. Hall's collections of root-beds resembling those of Gaspé. In New York only the Upper and Middle Devonian have as yet afforded land-plants; but in Gaspé *Psilophyton princeps* occurs in the Lower Devonian, and fragments which may have belonged to it occur in the Upper Silurian.

31. *PSILOPHYTON ELEGANS*, sp. nov. Pl. XIV. figs. 29, 30; and Pl. XV. fig. 42.

Stems slender, produced in tufts from thin rhizomes, bifurcating and curving at their summits. Surface smooth, with very delicate wrinkles. Fructification in groups of small, broadly oval scales, borne on the main stem below the points of bifurcation.

I distinguish this species from *Psilophyton princeps* by its smaller size, its smoother surface, its growth in tufts, and the different form of its organs of reproduction. Still it must be admitted that imperfect specimens could not readily be distinguished from branchlets of *P. princeps*. It was found by Mr. Matthew in the shales near Carlton.

32. *PSILOPHYTON*? *GLABRUM*, sp. nov.

Smooth, flattened, bifurcating stems, two lines in width, with a slender woody axis.

These are objects of doubtful nature. They must have been stems or roots, bifurcating in the manner of *Psilophyton*, but having a very slender woody axis. They may have been either roots of some plant, or stems of a smooth and comparatively succulent species of *Psilophyton*.

33. SELAGINITES FORMOSUS, Dawson.

'Canad. Nat.' vol. vi. p. 176, figs. 11, 12; *Knorria* (?), Quart. Journ. Geol. Soc. vol. xv. p. 486, fig. 5.

"Stems covered with flat, broad, angular, imbricating scales of unequal size, and ornamented with minute scaly points."

This is the plant noticed in my paper on the plants of Gaspé* as probably a *Knorria*. Better specimens have subsequently enabled me to describe it as above, and to refer it to *Selaginites*, without, however, maintaining that it is certainly a Lycopodiaceous plant. It occurs in the shales associated with the Devonian coal-seam at Gaspé.

34. LEPTOPHLEŒUM RHOMBICUM, nov. gen. et sp. Pl. XII. fig. 8; and Pl. XVII. fig. 53.

Stem covered with contiguous rhombic areoles, each with a single small scar a little above its centre, and above this a very slight furrow. Decorticated stems with spiral punctiform scars in slight depressions. Bark thin. Pith-cylinder very large, with transverse markings of the character of Sternbergia.

This plant seems to have presented a straight cylindrical stem, supporting leaves with thick bases, and of which only traces remain. Its bark was thin; and it seems to have had a thin woody cylinder, within which was a very large *Sternbergia*-pith. One specimen shows a growth of young wood at the extremity of the stem, on which the rhombic scars are only imperfectly developed; and at the extremity of this younger portion, the transverse structure of the pith exhibits itself through the thin bark in such a manner that this portion, if separated from the remainder of the stem, might be described as a *Sternbergia*. This is another peculiar phase of these remarkable, transversely wrinkled piths that seem to have belonged to so many of the Carboniferous and Devonian plants. The markings on the surface of the stems of this plant somewhat resemble those of *Lepidodendron tetragonum*, *Ulodendron minus*, and *Lomatoflojos crassicaule*, but the vascular scars and the general structure of the stem are quite different. Still I believe this plant to be more nearly allied to *Ulodendrea* and *Lepidodendrea* than to any other plants.

35. CORDAITES ROBBII, Dawson. Pl. XIV. fig. 31 a, b, c.

Leaves elongated, lanceolate, sometimes three inches wide and a foot in length. Veins equal and parallel. Base broad, clasping the stem, point acuminate.

When this species was described in my paper in the 'Canadian Naturalist†,' only very imperfect specimens were in my possession; but numerous and fine specimens recently found now enable me more perfectly to characterize the species. The leaves vary much in form; and in their young state, as represented in fig. 31 a, were

* Quart. Journ. Geol. Soc. vol. xv. p. 486.

† May 1861, p. 168.

often of a regularly oblong form. They have numerous equal parallel nervures, which were probably fibro-vascular, like those of Ferns, as they present precisely the same appearance as the nervures of the plants of this family preserved with them, and which, in these beautiful graphitized specimens, are traced in deeper lines of graphite than the film of the same material which represents the intervening parenchyma. In the best-preserved specimens, the leaf is quite smooth; but in some the space between the nervures rises into little ridges, so as to give a striated appearance. These different aspects, however, often occur on different portions of the same leaf. The present species so closely resembles *C. borassifolia* of the Coal-formation that it might readily be mistaken for it; but it differs somewhat in the form of the leaf, and still more in the venation, the nervures in the present species being perfectly equal*.

In the paper already referred to, I have stated at length my reasons for preferring, in the case of this plant and *C. borassifolia*, the generic name *Cordaïtes*, to *Poacites*, *Flabellaria*, and *Neggerathia*, all of which have been applied to such plants, together with others having no affinity to them. To the name *Pychnophyllum*, proposed by Brongniart, this objection does not apply; but *Cordaïtes*, I believe, has priority, and is due to the describer of the typical species.

I associate the genus *Cordaïtes* with Lycopodiaceous plants without hesitation, notwithstanding the peculiar character of its foliage, because Corda has shown that its stem is strictly acrogenous in structure, and of the same type with those of *Lomatoflojos* and *Ulodendron*—a fact which excludes it alike from association with Monocotyledonous plants and with Ferns.

It is worthy of notice that, while the leaves of *Cordaïtes*, unlike those of *Sigillaria* and *Lepidodendron*, were not attached by narrow bases, but clasping, they were still, like those of nearly all other Devonian and Carboniferous plants, deciduous and capable of disarticulation, as is proved by the immense abundance of fallen leaves, while the stems, probably remaining attached to the soil, are rare. It is further to be observed that these leaves were rigid, and long resisted decomposition; on which account, no doubt, they formed a favourite base of attachment for the little *Spirorbes* which swarmed both in the Devonian and Carboniferous Periods. At St. John many of these leaves are covered with these little shells.

The leaves of the present species are very abundant in the shales of the vicinity of St. John, and indeed are eminently characteristic of them; and on this account I regard the dedication of it to my late lamented friend, Dr. Robb, as specially appropriate. I have not recognized this plant in the specimens from Gaspé or Perry; and the only indication of it in the New York collection is a fragment of a leaf from the Hamilton group of Cazenovia, New York, not sufficiently perfect to render its identification certain.

* The nervures in *C. borassifolia* are alternately thick and thin; but there is an undescribed species in the Upper Coal-measures of Nova Scotia which has equal nervures.

36. *CORDAITES ANGUSTIFOLIA*, Dawson.

Leaves linear, much elongated, one-tenth to one-fourth of an inch broad, with delicate, equal, parallel nervures.

This species, originally described from specimens collected at Gaspé, where it abounds in the roof of the little Devonian coal-seam, occurs also at St. John, and in the Marcellus Shale of New York; and it has also been found by Sir W. E. Logan in the *Upper Silurian* of Cape Gaspé, together with fragments which may have belonged to *Psilophyton*. It usually occurs as long riband-like detached leaves, not always easily distinguishable from the flattened stems and roots of other plants found in the same beds. I have not seen the apex nor the base of the leaf, but among Prof. Hall's specimens from the Marcellus Shale is one which appears to consist of the remains of several leaves, attached to a short stem, of which the structure and markings have perished.

Plants closely resembling this are described by Unger and Göppert, from the Devonian of Europe; but the characters given do not enable me to identify any of them with the present species. Such plants are placed by those writers in the genus *Næggerathia*, which I reject for the reasons above stated.

37. *CORDAITES* (?). Pl. XVI. fig. 59.

One of Prof. Hall's specimens from the Hamilton group is a cast of a stem which appears to have produced closely adpressed clasping leaves, obscurely striated, and widening upward. I refer it to this genus, but cannot determine whether it belonged to either of the species above described or to a third, though perhaps the latter is the more probable supposition.

38. *MEGAPHYTON* (?).

An obscurely marked stem in Mr. Richardson's collection, from Perry, appears to indicate a plant of this genus, but does not afford sufficient characters for description.

(Filices.)

39. *CYCLOPTERIS HALLIANA*, Göppert. Pl. XVII. figs. 54, 55.

Göppert, 'Flora Silurisch.' p. 498; *Sphenopteris lawa*, Hall, 'Report Geol. New York,' p. 275, fig. 127.

The original specimen of this beautiful plant has been submitted to me by Prof. Hall, and corresponds very closely with the figure above referred to, and with Göppert's description, based on that figure. The nervures, which Göppert notes as simple or dichotomous, are apparently the latter, and the pinnules seem to have been slightly lobed at the margins as in *Adiantum*. Its densely leafy rachis, with its rich terminal pinnules and delicate drooping lateral pinnae, give it an appearance at once unique and graceful; while the form, arrangement, and venation of the pinnules are peculiar

features of that antique group of Cyclopteroid Ferns so highly characteristic of the Devonian and Lower Carboniferous beds.

This group of Ferns, including the present species, with *C. Jacksoni*, *C. obliqua*, *C. Hibernica*, and others, is no doubt generically distinct, as Lesquereux very properly maintains, from the *Cyclopterides* of the Coal-measures; but this industrious observer has unfortunately applied to it the generic name *Næggerathia*, which is used by Unger, Göppert, and others for leaves with parallel striation and supposed to be monocotyledonous. On this account, rather than increase the confusion of the nomenclature, I in the meantime retain, with the above explanation, the name *Cyclopteris*. The present species occurs in the Chemung group of New York.

40. *CYCLOPTERIS JACKSONI*, Dawson.

'Canad. Nat.' vol. vi. p. 173, fig. 9.

"*Frond bipinnate; rachis stout and longitudinally furrowed; pinnae alternate; pinnules obliquely obovate, imbricate, narrowed at the base, and apparently decurrent on the petiole; nerves nearly parallel, dichotomous; terminal leaflet large, broadly obovate or lobed.*"

This species, first described, in my paper in the 'Canadian Naturalist,' from a specimen found at Perry, occurs also in small fragments at St. John, and large specimens occur in the collection of Prof. Hall from the Old Red Sandstone of Montrose, New York. It is closely allied to *C. Hibernica*, and is its American representative.

41. *CYCLOPTERIS OBTUSA*, Lesquereux. Pl. XV. fig. 33.

To this species, described by Lesquereux, from the Old Red Sandstone of Pennsylvania, I refer a beautiful Fern not unfrequent in the shales near St. John. Lesquereux places it, for the reasons above mentioned, in the genus *Næggerathia*.

42. *CYCLOPTERIS VALIDA*, sp. nov. Pl. XVII. fig. 52.

Tripinnate; primary divisions of the rachis stout and wrinkled. Pinnae regularly alternate. Lower pinnules nearly as broad as long, deeply and obtusely lobed, narrowed and decurrent at the base; regularly diminishing in size and breadth toward the point, and the last pinnules narrowly obovate and confluent with the terminal pinnule. Nerves delicate, several times dichotomous.

This is the most perfect and beautiful of the St. John Ferns. It resembles at first sight *Sphenopteris macilentia*, L. & H.; but on examination it differs materially in details. It is an elaborate and ornate example of the peculiar type of *Cyclopteris* already referred to as characteristic of the Upper Devonian Period.

43. *CYCLOPTERIS VARIA*, sp. nov. Pl. XV. fig. 34.

Pinnate (or bipinnate). Pinnae with a thick petiole. Pinnules decreasing in size to the terminal one, which is ovate and lobed. Pinnules oblique, decurrent on one side. Nerves frequently dichotomous.

This Fern has been found only in fragments. It seems to have

been a thick fleshy frond, but the specimens are insufficient to show its habit of growth. Its nearest allies seem to be *C. Villiersi*, Sternberg (*Neuropteris Villiersi*, Brongn.), and *Cyclopteris heterophylla*, Göppert; but it differs from both.

44. *CYCLOPTERIS BROWNII*, sp. nov. Pl. XII. fig. 9.

Pinnules large, cuneate, with distant, once-forked nerves, and waved margins.

This is a mere fragment, but indicates a very distinct plant from any known to me elsewhere. It was collected at Perry by Prof. C. H. Hitchcock, and is named in honour of Mr. Brown, of Perry, one of the earliest explorers of the beds at that place.

45. *CYCLOPTERIS INCERTA*, sp. nov. Pl. XVI. fig. 44.

Stipes half an inch in diameter, giving off branches at acute angles, on which are borne, below, branching and recurved remains of fertile pinnules and, above, traces of terminal obovate pinnules.

I describe this plant rather as an indication of a species than as one actually known. The parts remaining are similar in arrangement to those of *Cyclopteris Acadica* of the Lower Coal-measures of Nova Scotia, and prove the existence of a somewhat similar species during the era of the Hamilton group in New York, from which this specimen is derived.

46. *NEUROPTERIS SERRULATA*, sp. nov. Pl. XV. fig. 35 *a, b*.

Bipinnate. Rachis thin and slender. Pinnæ alternate, sparsely placed, and of few pinnules. Pinnules obovate, narrowed at base, sessile, delicately but sharply serrate, especially at the apex. Terminal leaflet rounded and lobed, scarcely serrulate. Midrib visible nearly to the apex. Pinnules about two lines in length.

From the St. John shales, where it seems to be rare. It is a delicate little species, quite distinct, in so far as I am aware, from any heretofore described.

47. *NEUROPTERIS POLYMORPHA*, sp. nov. Pl. XV. fig. 36 *a, b, c*.

Pinnate or bipinnate. Rachis or secondary rachis irregularly striate. Pinnules varying from round to oblong, unequally cordate at base, varying from obtuse to acute. Terminal leaflet ovate, acute, angulated or lobed. Midrib delicate, evanescent. Nervures slightly arcuate, at acute angles with the midrib.

This Fern is very abundant in the shales near Carlton, at St. John. At first sight it appears to constitute several species, but careful comparison of numerous specimens shows that all the various forms figured may occur on the same frond. In its variety of forms it resembles *N. heterophylla*, Brongn., or *N. hirsuta*, Lesquereux; but it differs from the former in its delicate midrib and acutely angled nervures, and from the latter in its smooth surface.

48. *SPHENOPTERIS HÆNINGHAUSI*, Brongniart.

One of the Ferns from the shales near St. John appears to be.

identical with the above species, which belongs to the Lower Carboniferous of Europe.

49. SPHENOPTERIS MARGINATA, sp. nov. Pl. XV. fig. 38 a, b.

This resembles the last species in general form, but is larger, with the pinnules round or round-ovate, divided into three or five rounded lobes, and united by a broad base to the broadly winged petiole.

Found with the preceding. One specimen, given to me by Mr. Hartt, shows a frond 6 inches in length.

50. SPHENOPTERIS HARTTII, sp. nov. Pl. XVI. fig. 48 a, b.

Bipinnate or tripinnate. Divisions of the rachis margined. Pinnules oblique, and confluent with the margins of the petiole; bluntly and unequally lobed. Nerves small, oblique, twice-forked.

This beautiful Fern very closely resembles *S. alata* from the coal-field of Port Jackson, but differs in several of its details. I name it in honour of Mr. Hartt, the discoverer of several of the St. John Ferns. Found with the preceding.

51. SPHENOPTERIS HITCHCOCKIANA, sp. nov. Pl. XVI. fig. 51 a, b, c.

Stipes stout, straight, rugose, giving off slender secondary petioles, which ramify dichotomously and terminate in minute obovate leaflets.

This beautiful plant, from Perry, which I name in honour of its discoverer, who worthily bears a name long noted in American Geology, has the aspect rather of a stem with excurrent branchlets than of a frond. Its venation cannot be distinguished. It belongs to a peculiar group or subgenus (*Davallioides* of Göppert) characteristic of the Devonian and Lower Carboniferous, and represented in Europe by such plants as *S. petiolata*, Unger, *S. refracta*, Göppert, and *S. Devonica*, Unger. Some of these plants (and this applies to the one now noticed) convey the impression that they may be sub-aquatic portions of Ferns bearing pinnules of different form in the air. Immense numbers of leaflets, apparently of this species, are scattered over certain surfaces of the St. John shales, but have not yet been seen in connexion with their rachis; and one of Prof. Hall's specimens from New York exhibits a stipe quite like that of the present species, but with mere traces of the pinnæ.

52. HYMENOPHYLLITES CURTILOBUS, sp. nov. Pl. XV. fig. 39.

Bipinnate. Rachis slender, dichotomous, with divisions margined. Leaflets deeply cut into subequal obtuse lobes, each one-nerved, and about one-twentieth of an inch wide in ordinary specimens.

According to Lesquereux, the genus *Hymenophyllites* is characteristic in America of the Upper Devonian. In Europe it is represented also in the Lower Coal. I have not seen any species in the Carboniferous rocks of Nova Scotia or New Brunswick. The present is the only new species occurring at St. John. It resembles a gigantic

variety of *H. obtusilobus*, Gæppert (*Sphenopteris trichomanoides*, Brongn.).

53. HYMENOPHYLLITES OBTUSILOBUS, Gæppert.

Found with the preceding.

54. HYMENOPHYLLITES GERSDORFFII, Gæppert. Pl. XV. fig. 37.

Found with the preceding.

55. PECOPTERIS (ALETHOPTERIS) DECURRENS, sp. nov. Pl. XV. fig. 40 a, b, c.

Bipinnate. Pinnules rather loosely placed on the secondary rachis, but connected by their decurrent lower sides, which form a sort of margin to the rachis. Midrib of each pinnule springing from its upper margin and proceeding obliquely to the middle. Nerves very fine and once-forked. Terminal leaflet broad.

This Fern so closely resembles *Pecopteris Serlii* and *P. lonchitica* that I should have been disposed to refer it to one or other of these species but for the characters above stated, which appear to be constant. *P. Serlii* is abundant in the Lower Carboniferous of Northern New Brunswick, and *P. lonchitica* is the most common Fern throughout the whole thickness of the Joggins Coal-measures; but in neither locality does the form found at St. John occur. On this account I think it probable that the latter is really distinct. In Murchison's 'Siluria,' 2nd edit., p. 321, a Fern from Colebrook Dale is figured as *P. lonchitica*, which, so far as I can judge from the engraving, may be identical with the present species. Locality, St. John.

56. PECOPTERIS (ALETHOPTERIS) INGENS, sp. nov. Pl. XV. fig. 41 a, b.

Pinnules more than an inch wide, and three inches or more in length, with nervures at right angles to the midrib and forking twice.

Only a few fragments of pinnules of this species have been found in the shales near St. John. They are usually doubled along the midrib, as if it had been their habit to be folded in a conduplicate manner. Their general aspect suggests a resemblance to the Mesozoic Tæniopterids rather than to the Pecopterids of the Coal-formation.

57. PECOPTERIS (ALETHOPTERIS). Pl. XVI. fig. 49.

Mr. Hartt has recently sent to me, from St. John, a pinna of a *Pecopteris* having oblong, obtuse pinnules attached by the whole base, with a slender midrib, and slightly repand edges. The nervures are not preserved. It closely resembles *A. obscura*, Lesquereux, from the Coal of Pennsylvania.

58. TRICHOMANITES (?). Pl. XVI. fig. 50 a, b.

A minute frond, collected at St. John by Mr. Hartt, may possibly represent a plant of this genus; but it may be merely the nervures of a leaf whose parenchyma has been removed by decay.

59. RHACHIOPTERIS PINNATA. Gen. et sp. nov. Pl. XVI. fig. 60.

Stipes half an inch wide or less, unevenly striate, giving off opposite branches, which are abruptly broken off at short distances from the stipe.

Unger has established as a provisional family, under the name of *Rhachiopterides*, a number of species, referred to several genera, of stipes of ferns showing structure; and I now propose under the above name to include such Devonian stipes as indicate the existence of distinct species of Ferns, of which the fronds have perished. This has the advantage of provisionally recognizing the existence of such species, and of preventing their stipes from being referred, in their flattened state, to other families of plants. It also serves to remind us of the fact that, while in some localities we have a number of species of Ferns in a good state of preservation, in others an equal number of species are represented only by fragments of stipes. The latter state of things is especially noteworthy in the Middle Devonian of New York, from the lower member of which, the Marcellus Shale, the present species is derived.

60. RHACHIOPTERIS CYCLOPTEROIDES, sp. nov.

Very thick stipes, not observed to branch, and marked with uneven longitudinal striae.

Base of the Catskill group, New York.

61. RHACHIOPTERIS PUNCTATA, sp. nov. Pl. XVI. fig. 61.

Stipes marked with obscure longitudinal ridges, between which are transverse furrows or punctures; greatest diameter an inch.

These stipes are marked in the manner of those of *Cyclopteris Rimeriana*, Göppert, of the Upper Devonian; and Unger figures a similar stem from the Devonian of Thuringia. The present specimens are from the Catskill group of New York. Fragments with similar markings occur both at St. John and Gaspé.

62. RHACHIOPTERIS STRIATA, sp. nov.

Stipes regularly and distinctly striated longitudinally.

Many short fragments of these stipes occur on the surfaces of beds of the Chemung group at Richfield, Ohio, and the Hamilton group at Akron, Ohio. They are not distinguishable from similar fragments of the stipes of *Cyclopteris Acadica*, and, like these, might, when flattened, be mistaken for leaves with parallel veins.

63. RHACHIOPTERIS TENUISTRIATA, sp. nov. Pl. XIV. fig. 32 a, b; and Pl. XVI. figs. 45, 46.

Stipes smooth, finely striated, and in some specimens with little linear ridges scattered over the surfaces, and perhaps marking the position of minute hairs. Largest stems an inch in diameter, branching pinnately and dichotomously, and terminating in recurved divisions or in long flattened petioles.

More than one species may possibly be included under this name;

but all the specimens are apparently stipes of species of *Cyclopteris* or *Sphenopteris*. They occur in the Genesee Shale and Marcellus Shale. Many somewhat similar stipes occur at Perry and at Gaspé.

Note.—Since writing the above paper, I have received from Mr. Hartt two additional Ferns, collected by Mr. Lann and Mr. Payne, of St. John. One of them is a pinnule of a *Neuropteris*, in some points resembling *N. gigantea*. It is about an inch in length, broadly oval in form, and with a thick and persistent midrib and crowded nervures, forking twice. The other is a *Sphenopteris*, with elongated pinnatifid pinnae, much in the style of *S. intermedia*, Lesquereux. Neither of these plants seems identical with any described species; but more perfect specimens are required for their description.

(*Incertæ sedis.*)

64. *CARDIOCARPUM CORNUTUM*, sp. nov. Pl. XIII. figs. 23, 24.

Broadly ovate, emarginate at base, dividing into two inflexed processes at top. A mesial line proceeds from the sinus between the cusps, downward. Nucleus more obtuse than the envelope, and acuminate at the top. Surface of the flattened envelope striate, that of the nucleus more or less rugose. Length about seven lines.

Numerous in shale near St. John. The specimens are all perfectly flattened, and many of them are also distorted, being elongated or shortened according to the direction in which they lie in the shale. The nucleus constitutes a strongly shaded spot of graphite. The flattened envelope appears as a less distinct wing or border.

65. *CARDIOCARPUM OBLIQUUM*, sp. nov. Pl. XIII. fig. 25.

Unequally cordate, acuminate, smooth, with a strong rib passing down the middle; length about three lines.

Found with the preceding. It somewhat resembles some of the forms of *C. acutum*, L. & H.

66. *TRIGONOCARPUM RACEMOSUM*, sp. nov. Pl. XVI. fig. 47 a, b, c.

Ovate, obtusely acuminate, in some specimens triangular at apex. In flattened specimens the envelope appears as a wing. Attached in an alternate manner to a thick, flexuous, furrowed rachis.

This is evidently a fruit or seed, borne in a racemose manner on a stout rachis. In some specimens the seeds are close to each other, in others more remote. Attached to some are apparently traces of calyx-leaves or bracts. Shales of St. John.

67. *ACANTHOPHYTON SPINOSUM*, gen. et sp. nov. Pl. XII. fig. 6 a, b.

Cylindrical branches, ramifying in an alternate manner, striated, and with scattered tubercles, on which are borne short spines or prickles.

These specimens, from the Hamilton group of New York, resemble fragments of branches of some spiny or prickly exogenous plant. The stipes of some Ferns, as *Neuropteris lineata*, have a spinous

appearance when deprived of their pinnules; but the present specimens are obviously of different character. In Prof. Hall's collections from the Chemung group there are similar stems, with tubercles, but with a minutely punctured surface. These may possibly indicate a distinct species.

(*Algæ*.)

Among Prof. Hall's specimens are several which probably belong to *Algæ*; but I regard them as too obscure in their affinities to merit detailed description, with the exception of the following.

68. UPHANTÆNIA CHEMUNGENSIS, VANUXEM. Pl. XVII. fig. 62.

Vanuxem's 'Report, Geol. New York,' p. 153, fig. 50.

Flabellate, invested, conical or hollow, cylindrical fronds, marked externally with cross striae, dividing the surface into rectangular spaces; and in the cylindrical forms with rows of tubercles.

Vanuxem has figured and described, under the above name, a flabellate frond which he represents as apparently consisting of tape-like bodies interwoven like basket-work. The specimens submitted to me have, however, rather the character of a continuous surface marked out into spaces by radiating and concentric striae. With these fan-like forms are associated others that are bluntly conical, and others still that are elongately conical or cylindrical; and some of the latter are covered with large tubercles arranged in vertical and transverse rows, so as to give an appearance like that of stems of the genus *Halonia*. One of these curious stem-like objects is illustrated by fig. 62 (from a photograph). Some of the specimens are much more finely marked than others, but there are gradations in this; and there are indications that some of the more finely marked stems had flabellate or conical fronds upon them. These objects are very perplexing, and are found in marine beds, but mixed with remains of land-plants. On the whole I regard them as *Algæ* with funnel-shaped fronds sometimes prolonged into cylinders, and, when adult, bearing fructification in tubercles on the sides of the cylinders. In general form these plants may be compared with *Algæ* of the family *Dictyotææ*; but there is no indication that they resembled these in details of structure. Some of the specimens have a slight carbonaceous coating. The cylindrical forms seem to have been regarded by Conrad as shells, and were named *Hydroceras*. The specimens in my possession are from the Chemung group in New York and Ohio. They may represent several species, but, on the other hand, it is quite possible that they may be different states and portions of the same plant.

Geological and Geographical Distribution of the Devonian Plants of Eastern America.

Names of Species.	Upper Silurian.	Lower Devonian.	Middle Devonian.		Upper Devonian.				
	Gaspé.	Gaspé.	Gaspé.	New York.	Gaspé.	New York.	Maine.	New Brunswick.	Pennsylvania.
1. <i>Syringoxylon mirabile</i>				*					
2. <i>Dadoxylon Ouangondianum</i>				*				*	
3. — <i>Halli</i>				*					
4. <i>Aporoxylon</i>				*			*		
5. <i>Prototaxites Logani</i> †			*						
6. <i>Sigillaria Palpebra</i>								*	
7. — <i>Vanuxemii</i>						*			
8. — <i>Simplicitas</i>				*					
9. <i>Syringodendron gracile</i>				*					
10. <i>Stigmara exigua</i>						*			
11. — <i>ficoides</i>								*	*
12. <i>Didymophyllum reniforme</i>				*					
13. <i>Calamites Transitionis</i>								*	*
14. — <i>cannseformis</i>								*	*
15. — <i>inornatus</i>				*	*				
16. <i>Asterophyllites acicularis</i>								*	
17. — <i>latifolia</i>								*	
18. — <i>scutigera</i>								*	
19. — <i>longifolia</i>								*	*
20. — <i>parvula</i>								*	
21. <i>Annularia acuminata</i>								*	
22. <i>Sphenophyllum antiquum</i>								*	
23. <i>Pinnularia dispalans</i>								*	
24. <i>Lepidodendron Gaspianum</i>			*	*	*	*	*	*	
25. — <i>Chemungense</i>						*	*	*	
26. — <i>corrugatum</i>						*	*	*	*
27. <i>Sagenaria Veltheimiana</i> ‡					*			*	*
28. <i>Lepidostrobus Richardsoni</i>						*		*	
29. — <i>globosus</i>						*		*	
30. <i>Lycopodites Matthewi</i>						*		*	
31. — <i>Vanuxemii</i>						*		*	
32. <i>Psilophyton princeps</i>	*	*	*	*	*	*	*	*	
33. — <i>elegans</i>						*		*	
34. — <i>glabrum</i>						*		*	
35. <i>Selaginites formosus</i>			*		*			*	
36. <i>Leptophleum rhombicum</i>					*		*	*	
37. <i>Cordaite Robbii</i>							*	*	
38. — <i>angustifolia</i>	*	*	*	*			*	*	*
39. <i>Cordaite</i> ?			*	*			*	*	
40. <i>Megaphyton</i> ?				*			*	*	
41. <i>Cyclopteris Halliana</i>					*		*	*	

† This species was not noticed in the descriptions, as no new facts relating to it had been obtained.

‡ I have marked this species as occurring in Pennsylvania, being of opinion that it is the same with *Lepidodendron primevum* of Rogers.

Geological and Geographical Distribution of the Devonian Plants of Eastern America (continued).

Names of Species.	Upper Silurian.	Lower Devonian.	Middle Devonian.		Upper Devonian.					Carboniferous.
	Gaspé.	Gaspé.	Gaspé.	New York.	Gaspé.	New York.	Maine.	New Brunswick.	Pennsylvania.	
42. <i>Cyclopteris Jacksoni</i>							*	*		
43. ——— <i>obtusa</i>								*	*	
44. ——— <i>valida</i>								*	*	
45. ——— <i>varia</i>								*	*	
46. ——— <i>Brownii</i>							*	*	*	
47. ——— <i>incerta</i>				*						
48. <i>Neuropteris serrulata</i>								*		
49. ——— <i>polymorpha</i>								*		
50. <i>Sphenopteris Hœninghausi</i> ..								*		*
51. ——— <i>marginata</i>								*		
52. ——— <i>Hartii</i>								*		
53. ——— <i>Hitchcockiana</i>							*	*		
54. <i>Hymenophyllites curtilobus</i> ..								*		
55. ——— <i>obtusilobus</i>								*		
56. ——— <i>Gersdorffii</i>								*		*
57. <i>Alethopteris decurrens</i>								*		*
58. ——— <i>ingens</i>								*		
59. ——— <i>obscura</i> ?								*		* ?
60. <i>Trichomanites</i>								*		
61. <i>Rhachiopteris pinnata</i>				*						
62. ——— <i>cyclopteroides</i>						*				
63. ——— <i>punctata</i>						*				
64. ——— <i>striata</i>				*		*				* ?
65. ——— <i>tenuistriata</i>				*						
66. <i>Cardiocarpum cornutum</i>								*		
67. ——— <i>obliquum</i>								*		
68. <i>Trigonocarpum racemosum</i> ..								*		
69. <i>Acanthophyton spinosum</i>								*		

III. CONCLUSION.

In the course of the preceding pages, I have endeavoured to notice points of general geological and botanical interest as they occurred; and it will now be necessary only to mention a few leading results, as to the Devonian Flora, which may be deduced from the observations above recorded.

1. In its general character the Devonian Flora resembles that of the Carboniferous Period, in the prevalence of Gymnosperms and Cryptogams; and, with few exceptions, the generic types of the two periods are the same. Of thirty-two genera to which the species described in this paper belong, only six can be regarded as peculiar to the Devonian Period. Some genera are, however, relatively much

better represented in the Devonian than in the Carboniferous deposits, and several Carboniferous genera are wanting in the Devonian.

2. Some species which appear early in the Devonian Period continue to its close without entering the Carboniferous; and the great majority of the species, even of the Upper Devonian, do not reappear in the Carboniferous Period; but a few species extend from the Upper Devonian into the Lower Carboniferous, and thus establish a real passage from the earlier to the later flora. The connexion thus established between the Upper Devonian and the Lower Carboniferous is much less intimate than that which subsists between the latter and the true Coal-measures. Another way of stating this is, that there is a constant gain in number of genera and species from the Lower to the Upper Devonian, but that at the close of the Devonian many species and some genera disappear. In the Lower Carboniferous the flora is again poor, though retaining some of the Devonian species; and it goes on increasing up to the period of the Middle Coal-measures, and this by the addition of species quite distinct from those of the Devonian Period.

3. A large part of the difference between the Devonian and Carboniferous Floras is probably related to different geographical conditions. The wide swampy flats of the Coal Period do not seem to have existed in the Devonian era. The land was probably less extensive and more of an upland character. On the other hand, moreover, it is to be observed that, when in the Middle Devonian we find beds similar to the underclays of the Coal-measures, they are filled, not with *Stigmaria*, but with rhizomes of *Psilophyton*; and it is only in the Upper Devonian that we find such stations occupied, as in the Coal-measures, by *Sigillaria* and *Calamites*.

4. Though the area to which this paper relates is probably equal to any other in the world in the richness of its Devonian Flora, still it is apparent that the conditions were less favourable to the preservation of plants than those of the Coal Period. The facts that so large a proportion of the plants occur in marine beds, and that so many stipes of Ferns occur in deposits that have afforded no perfect fronds, show that our knowledge of the Devonian Flora is relatively far less complete than our knowledge of that of the Coal-formation.

5. The Devonian Flora was not of lower grade than that of the Coal Period. On the contrary, in the little that we know of it we find more points of resemblance to the Floras of the Mesozoic Period, and of modern tropical and austral islands, than in that of the true Coal-formation. We may infer from this, in connexion with the preceding general statement, that in the progress of discovery very large and interesting additions will be made to our knowledge of this flora, and that we may possibly also learn something of a land fauna contemporaneous with it.

6. The *facies* of the Devonian Flora in America is very similar to that of the same period in Europe, yet the number of identical species does not seem to be so great as in the coal-fields of the two continents. This may be connected with the different geographical

On the FLORA of the DEVONIAN PERIOD in NORTH-EASTERN AMERICA.
By J. W. DAWSON, LL.D., F.G.S., Principal of M'Gill University,
Montreal.

APPENDIX, September 1862.—In a recent visit to Perry, the author (with the aid of Mr. Brown, of that place) thoroughly examined the present exposure of the plant-bearing bed. Among the specimens obtained were the following. (1.) Wood of a conifer of the genus *Dadoxylon*. (2.) A new *Stigmara* of the type of *S. exigua*. (3.) Specimens of *Lepidostrobus Richardsons*, showing it to have been the fructification of a new and interesting species of *Lycopodites*. (4.) Another species of *Lycopodites* allied to *L. Erdmanni*, Germar. (5.) A new species probably of the genus *Anarthrocanna*, Gœppert. (6.) A new *Cordaites*. (7.) More perfect specimens of *Cyclopteris Browniana*, showing it to have been a large and beautiful flabellate leaf or frond, possibly identical with that from the Upper Devonian of Pennsylvania, figured by Prof. Rogers, 'Pennsylvania Report,' vol. ii. part 2. pl. 22. (8.) A Fern allied to *Cyclopteris Jacksoni*, but with a stem similar to that of *C. Roemeriana*, Gœppert. (9.) New species of *Sphenopteris*, *Trichomanites*, and *Carpolites*. (10.) Specimens of *Leptophloeum rhombicum*, showing its leaves and fructification. These, with some interesting specimens recently collected by Mr. R. Bell, of the Geological Survey, at Gaspé, Dr. Dawson hopes to describe in a future paper.

ADDITIONAL NOTE, October 23, 1862.—I am informed by Prof. Hall, in a letter* bearing date Oct. 13th, 1862, that recent observations made by Prof. Orton, Mr. Way, and himself, indicate that the beds which have afforded the plants noticed in this paper as from the Catskill group of New York really belong to a somewhat lower horizon, that of the Chemung group, while the Catskill group proper, as now restricted by Prof. Hall, has not afforded any of these fossils.

This restriction renders it desirable that the following *corrigenda* should be made in my paper:—

- Page 298, line 2, for Catskill Group read Chemung and Portage Groups.
- " " line 7, *dele* Chemung Group.
- " 307, line 2 from bottom, foot-note, for Catskill read Chemung.
- " 313, line 2, for Catskill read Chemung.
- " 315, line 14, for Catskill Group read same group.
- " 323, line 22, for Base of the Catskill group read From the Middle Devonian of.
- " " line 29, for Catskill read Chemung.

J. W. D.

* See letter from Professor Hall to Dr. Dawson, on the corrected range of the Catskill and Chemung groups in New York, in the Canad. Nat. and Geol. vol. vii. No. 5, October 1862, p. 377.

conditions in these two periods; but the facts are not yet sufficiently numerous to prove this.

7. The above general conclusions are not materially different from those arrived at by Gœppert, Unger, and Bronn, from a consideration of the Devonian Flora of Europe.

EXPLANATION OF PLATES XII.—XVII.

Illustrative of the Devonian Flora of North-eastern America.

PLATE XII.

- Fig. 1. *Syringoxylon mirabile*: longitudinal section, highly magnified. *a*, woody fibres; *b*, medullary rays; *c*, ducts.
 2. —; transverse section.
 3. —; portion of a duct, highly magnified, showing the pores.
 4. —; medullary ray, highly magnified.
 5. —; transverse section, highly magnified; letters of reference as in fig. 1.
 6. *Acanthophyton spinosum*: *a*, smooth species or variety; *b*, punctated species or variety.
 7. *Sigillaria Vanuxemii*: *a*, retaining the outside; *b*, decorticated; *c*, axis.
 8. *Leptophleum rhombicum*: *a*, natural size; *b*, an areole enlarged.
 9. *Cyclopteris Brownii*.
 10. *Lepidodendron corrugatum*: *a*, portion of a small stem; *b*, part of a larger stem.

PLATE XIII.

- Fig. 11. *Dadoxylon Halli*: longitudinal section, magnified.
 12. *Sigillaria Palpebra*: *a*, natural size; *b*, an areole magnified.
 13. *Stigmaria exigua*.
 14. *Syringodendron gracile*: *a*, natural size; *b*, an areole magnified.
 15. *Didymophyllum reniforme*: *a*, natural size; *b*, an areole magnified.
 16. *Asierophyllites acicularis*: *a*, natural size; *b*, a leaf enlarged.
 17. *A. latifolia*: *a* and *c*, natural size; *b*, leaf enlarged.
 18. *A. scutigera*; ordinary aspect of the stem. 19. Apex of stem. 20. Stem compressed diagonally.
 21. *Annularia acuminata*.
 22. *Pinnularia dispalans*.
 23 & 24. *Cardiocarpum cornutum*.
 25. *C. acutum*.

PLATE XIV.

- Fig. 26, 27, 28. *Lepidodendron Gaspianum*, in various states.
 29 & 30. *Psilophyton elegans*: *a*, fructification.
 31. *Cordaites Robbii*: *a*, a group of young leaves; *b*, point of leaf; *c*, base of leaf; *d*, venation magnified.
 32. *Rhachiopteris tenuistriata*: *a*, natural size; *b*, a portion magnified.

PLATE XV.

- Fig. 33. *Cyclopteris obtusa*.
 34. *C. varia*.
 35. *Neuropteris serrulata*: *a*, natural size; *b*, a pinnule enlarged.
 36. *N. polymorpha*: *a* to *g*, various forms of pinnules.
 37. *Hymenophyllites Gersdorffii*: *a*, natural size; *b*, magnified.
 38. *Sphenopteris marginata*: *a*, natural size; *b*, magnified.
 39. *Hymenophyllites obtusilobus*; natural size.
 40. *Pecopteris decurrens*: *a*, a portion of a frond; *b*, terminal leaflet (*c*, magnified).
 41. *P. ingens*: *a*, natural size; *b*, magnified.

Fig. 42. *Psilophyton elegans*, portion of stipe.

43. Fragment of stem of *Asterophyllites*.

PLATE XVI.

Fig. 44. *Cyclopteris incerta*: *a*, stipe; *b*, remains of fertile pinnules; *c*, remains of leaflets.

45 & 46. *Rhachiopteris tenuistriata*.

47. *Trigonocarpum racemosum*: *a* and *b*, natural size; *c*, fruit, magnified.

48. *Sphenopteris Hartii*: *a*, terminal pinna; *b*, portion of frond.

49. *Alethopteris obscura*?

50. *Trichomanites* (?): *a*, natural size; *b*, portion enlarged.

51. *Sphenopteris Hitchcockiana*: *a*, natural size; *b*, *c*, pinnules magnified.

59. *Cordaites* (?) (from a photograph).

60. *Rhachiopteris pinnata* (from a photograph).

61. *R. punctata* (from a photograph).

PLATE XVII.

Fig. 52. *Cyclopteris valida*: *a*, natural size; *b*, pinnule enlarged.

53. *Leptophlaeum rhombicum*: *a*, immature portion of stem, showing Sternbergian structure.

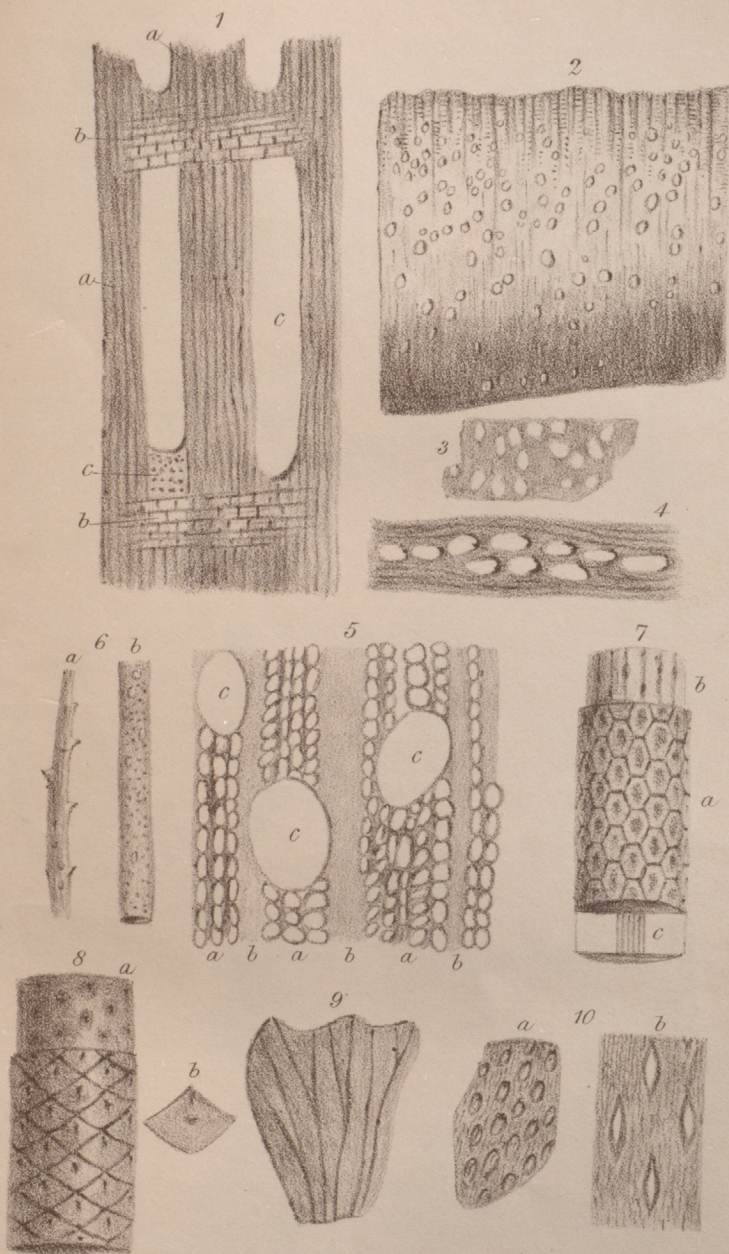
54. Terminal pinna of *Cyclopteris Halliana*. 55. Lateral pinna.

56. *Calamites inornatus*; one-third of natural size.

57. *Lycopodites Vanuxemii*.

58. *Lepidodendron Gaspianum*; portion of stem, flattened, covered with bark, and retaining remains of the leaves.

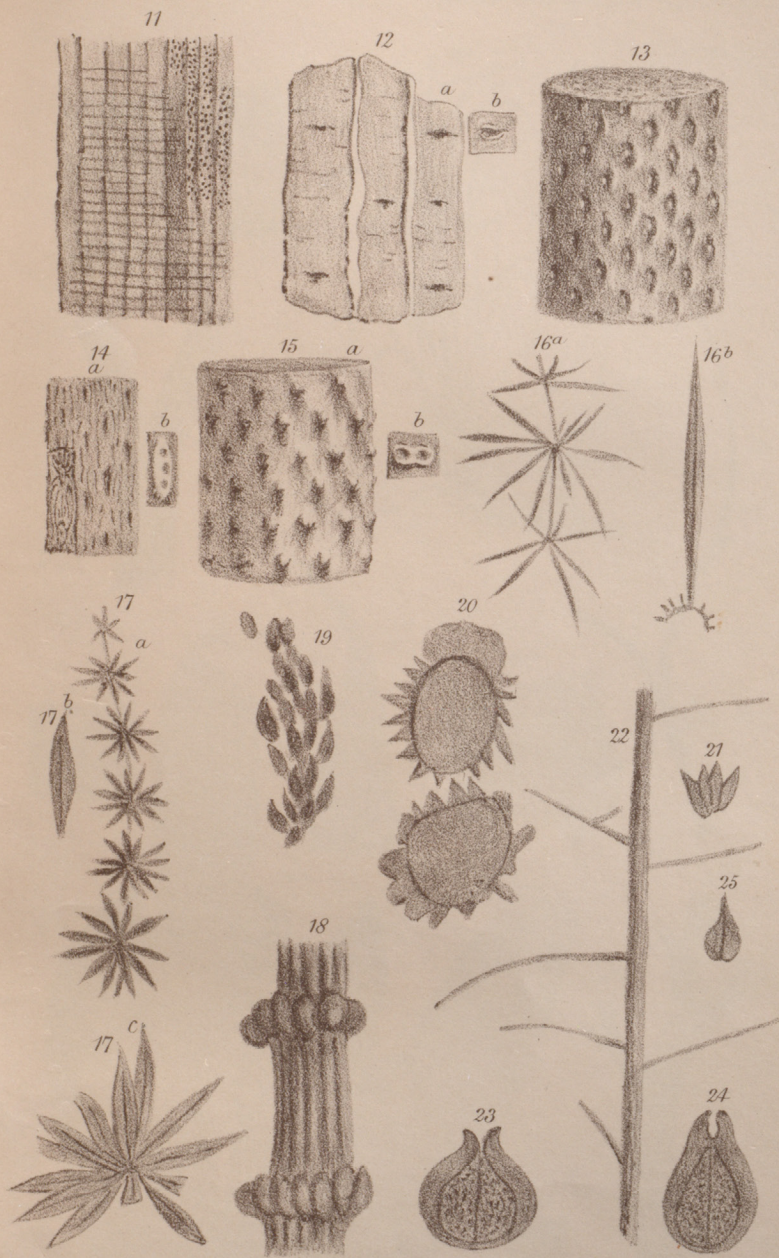
62. *Uphantænia Chemungensis* (from a photograph).



J.W.D. del.

W. West imp.

DEVONIAN PLANTS, N.E. AMERICA.



J.W.D. del.

DEVONIAN PLANTS, N.E. AMERICA.

W. West imp.

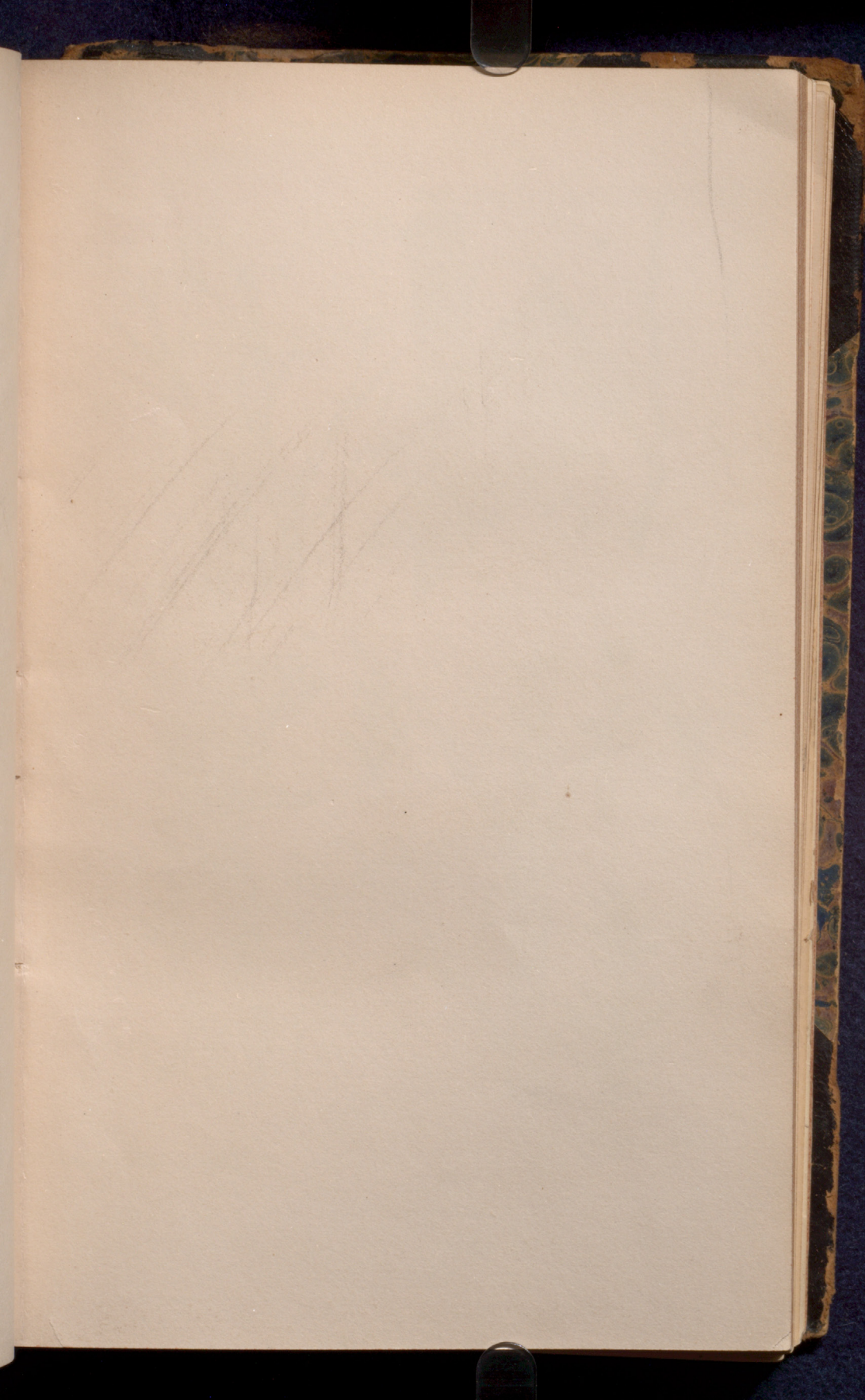


J.W.D. del.

DEVONIAN PLANTS, N.E. AMERICA.

W. West imp.

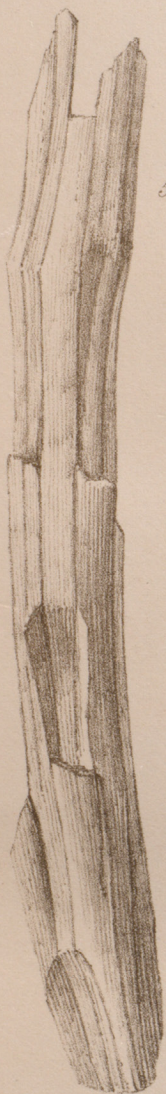




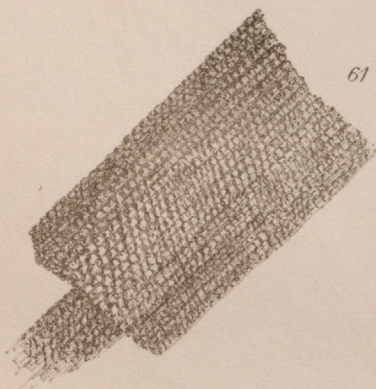


J.W.D. & G. de W. del.

DEVONIAN PLANTS



59

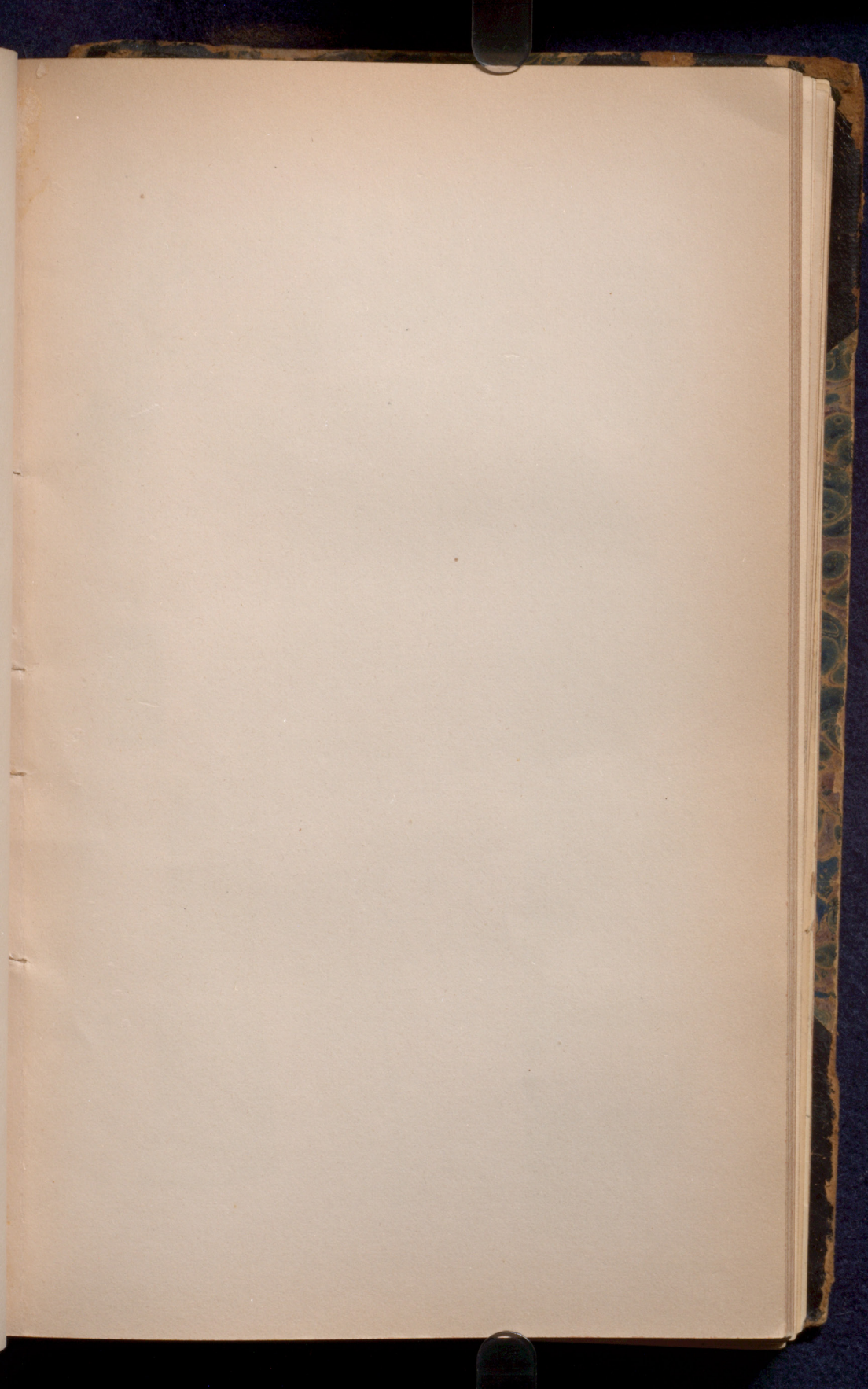


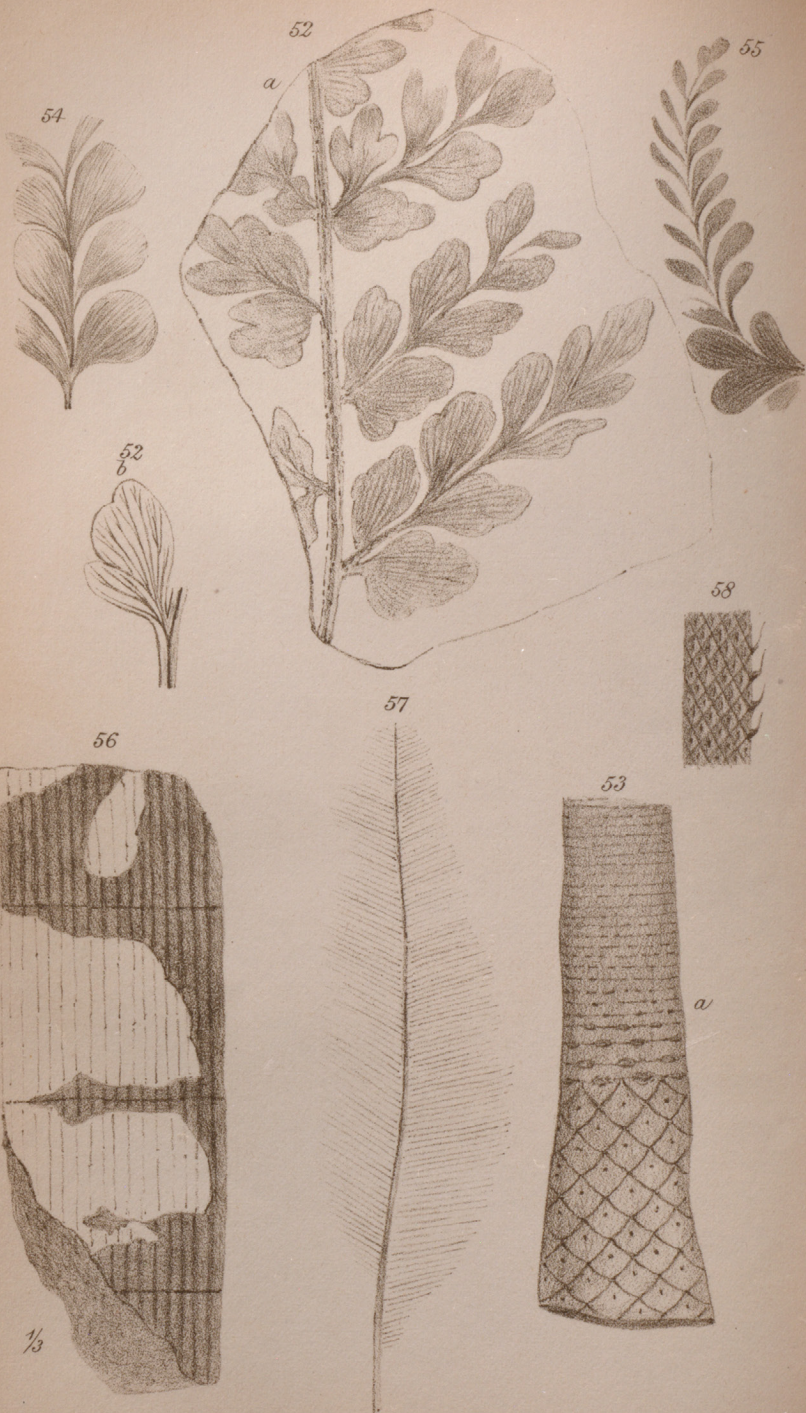
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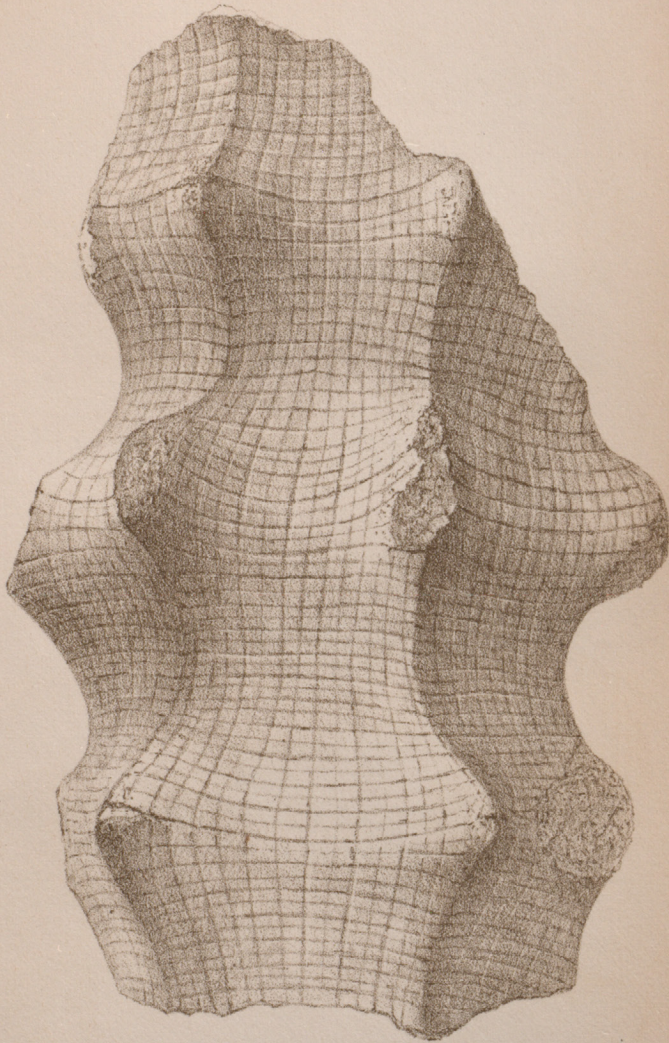




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DEVONIAN PLANTS

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FURTHER OBSERVATIONS
ON THE
DEVONIAN PLANTS OF MAINE, GASPÉ,
AND
NEW YORK.

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[PLATES XVII.-XIX.]

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§ I. *Introduction.*

SINCE the preparation of my paper "On the Devonian Flora of North-eastern America," published last year*, I have been enabled to explore more thoroughly than heretofore the plant-bearing beds at Perry, in Maine; and Mr. R. Bell, of the Geological Survey of Canada, has collected some interesting specimens from the Gaspé sandstones, which have been kindly placed in my hands by Sir W. E. Logan for determination. Some important facts have also been ascertained respecting the distribution of the Devonian rocks of the State of New York, which give to several of the Plants from that region a somewhat older geological position than that assigned to

* Quart. Journ. Geol. Soc. vol. xviii. p. 296.

them in my former paper. These supplementary facts I now propose shortly to state.

§ II. *Perry, Maine.*

With respect to the geological relations of the rocks at this place, I have little to add to the descriptions of Professor Hitchcock, referred to in my former paper. The beds at Pigeon Hill and its vicinity, referred by him to the Upper Silurian, consist of hard, grey and reddish shale and sandstone, overlain by trappean or trap-ash beds, and traversed by trap-dykes. They are somewhat, but very unequally, hardened and altered, and are inclined at high angles, with prevailing dips to the north-east. They contain abundance of *Lingule*, and of small Lamellibranchiate Shells which have been referred to the genus *Modiolopsis*. Mr. Billings regards the *Lingula* as an undescribed species, and it appears to differ from that found at St. John. I think it quite possible, however, that these beds at Perry may be the equivalents of the St. John slates; and from their relation to other beds at Pembroke which contain fossils of Lower Helderberg age, and identical in many species with my "Arisaig group" in Nova Scotia, I cannot doubt that they are of Upper Silurian date, unless indeed they may be Lower Devonian.

Upon these beds repose, in an unconformable manner, the Devonian red conglomerates. In their lower part they contain thick beds of coarse breccia, containing angular fragments of the harder members of the underlying series, sometimes 3 feet in length. These beds are well seen at the mouth of the Little River of Perry, near Point Pleasant. Above these are red conglomerates, with rounded pebbles of quartzite, syenite, and other hard rocks. The pebbles are of moderate size; and there are interstratified beds of bright red sandstone, with green spots and stains, and occasional thin grey layers. The thickness of these beds exposed on the south side of Little River is about 1300 feet. They are probably the equivalents of the upper part of the St. John series and the Upper Red Sandstones of Gaspé; and it is worthy of note, as suggesting a caution to explorers of those regions, that these rocks strikingly resemble in their mineral character the Lower Carboniferous red sandstones and conglomerates of some parts of Nova Scotia and New Brunswick, and also the probably Mesozoic "New Red Sandstones" of these provinces.

The fossil Plants occur most abundantly in a layer of grey sandstone, about 2 feet thick, and apparently of small horizontal extent, in the upper part of the red conglomerate. This little bed is filled with fragments of Plants, and probably occupies a spot where a stream running from neighbouring land emptied itself into the sea. It is rather a portion of the red sandstone bleached by the deoxidizing and solvent action of the vegetable matter, than a distinct bed; and the same remark applies to the numerous grey spots and thin layers in other parts of the series. A very pretty illustration of this occurs in a bright-red, fine-grained sandstone farther up the Little River, in which Mr. Jethro Brown, of Perry, has found fronds of *Cyclopteris Jacksoni*, and branches of *Psilophyton*, which have im-

printed themselves in light-greenish stains on the red stone. The Plants have been drifted, and are for the most part in fragments, the smaller and more delicate of which occur in the upper part of the bed, and those of larger size in its lower part. Above and below the Plant-bearing bed are red sandstones, passing into the usual red conglomerate. Though there are abundant exposures of the red sandstone and conglomerate on the coast of Perry, I could not learn that fossils have been found in any other locality than those above-mentioned, so that their occurrence must be considered rare. In the underlying Upper Silurian Series I could find no Plants, except some obscure fragments of slender stems.

With the assistance of Mr. Brown, I was enabled to obtain a number of specimens from the original Plant-bearing bed, the actual exposure of which we indeed worked out. The more important of these I shall now notice in detail.

1. CONIFEROUS WOOD (*DADOXYLON* ET *APOROXYLON*).

Among the most abundant fossils at Perry are fragments of stems and roots, and strips of bark, belonging to two or more species of coniferous trees. They are pyritized, so that their structures can be made out only as opaque objects, or after treatment with nitric acid. In the specimens formerly collected, I was able to observe only a porous woody tissue (*Aporoxylon*). Some of my present specimens, however, show three or four rows of discs on the cell-walls, and are not distinguishable from *Dadoxylon Ouangondianum* of St. John, though they are not in a sufficiently good state of preservation to admit of satisfactory comparison. Some of the flattened stems show marks of lateral branches or cones at rare intervals (Pl. XVIII. fig. 20); others are long, slender, and tortuous, and were probably roots (Pl. XVII. fig. 5).

Among the specimens collected by Mr. Brown is one with a porous tissue, in the form of a flattened stem or branch, 2 inches in diameter, and with a pith half an inch in diameter (not of the *Sternbergia*-type). The structure of the wood closely resembles that of *Aporoxylon primigenium*, Unger.

2. *STIGMARIA* PUSILLA, spec. nov. Pl. XVII. fig. 3.

Allied to S. exigua, but with larger and more distant scars, not in depressed areoles.

A few fragments of the bark of this species were found scattered over the surface of a slab at Perry. It is of the same slender type as *Stigmara exigua*, of the Chemung group of New York, but is sufficiently different to warrant the belief that it was the root of a distinct species of *Sigillaria*.

3. CYPERITES.

Two kinds of leaves, resembling those of *Sigillaria*, occur at Perry. They are a line or less in breadth and 3 inches or more in length, and have respectively two and four well-marked ribs. Though no trunks of *Sigillaria* have been found, I regard these leaves and

the *Stigmaria* above described as evidence of the existence of two species of that genus.

4. *ANARTHROCANNA* PERRYANA, spec. nov. Pl. XVIII. fig. 21.

Stem cylindrical, swelling slightly at the nodes; ribs flattened, about fourteen in the circumference of a stem three-fourths of an inch in diameter; ribs at the nodes apparently continuous with the decurrent verticillate (?) petioles or branchlets.

This curious stem at first sight resembles a *Calamites*; but it has no distinct articulation, and the ribs appear to separate from the stem and to pass into the decurrent and probably verticillate branchlets or petioles, which are given off at an acute angle, and bear traces of slender leaves, which are, however, too imperfect for description. The plant corresponds sufficiently, I think, with the characters of Gœppert's genus *Anarthrocanna* to be included in it. It was probably allied to *Calamites* or *Asterophyllites*; and possibly the species next mentioned may be the fruit of this Plant, though I have not seen them in connexion.

5. *CARPOLITHES* SPICATUS, spec. nov. Pl. XVII. fig. 15.

Carpels or spore-cases: oval, about a line in length, apparently with a thick outer coat; densely placed on a thick rachis.

This is evidently a spike of fructification, and may be allied to *Trigonocarpum racemosum*, described in my former paper. It more nearly resembles the fructification of *Annularia* and *Sphenophyllum* than any other fossil fruits known to me. Its parts are too indistinct to admit of minute description, and the two-ranked appearance of the seeds or fruits is probably deceptive, as there are indications that the specimen is a cylindrical spike flattened.

6. *LYCOPODITES* RICHARDSONI, spec. nov. Pl. XVII. figs. 1 & 2.

Stem slender, tortuous, dichotomous; barren branches with short erect or recurved leaves, apparently in two ranks; fertile branches lateral, one-sided, in the form of sessile strobiles. These strobiles are the Lepidostrobus Richardsoni of my former papers.

Under the name quoted in the above description, I described in a former paper* a very singular specimen collected at Perry by Mr. Richardson, and which, though at first sight it resembled a pinnate leaf, I believed to be a cone of the nature of *Lepidostrobus*. More perfect specimens confirm this view, and show that these cones were sessile on one side of a slender and probably creeping stem, terminating in dichotomous branches having short, stout, slightly recurved leaves, apparently in two rows. The generic name of *Lepidostrobus* being no longer applicable, I propose to place the Plant in *Lycopodites*, a genus no doubt at present somewhat unsettled, but in which this Plant, at least, fairly deserves a place.

7. *PSILOPHYTON*.

Fragments referable to this genus are very abundant at Perry,

* Canadian Naturalist, vol. vi. p. 174.

but all in a very imperfect state. I believe that I can recognize representatives of the three species which I have named respectively *P. princeps*, *P. elegans*, and *P. glabrum*, but cannot be quite certain of this. Here, as elsewhere, I should have been ready to refer these Plants to the convenient category of Fucoids, but for my knowledge of their forms and structures obtained in Gaspé.

8. LEPTOPHLEŒUM RHOMBICUM, Dawson. Pl. XVIII. fig. 19.

Additional specimens of this Plant have enabled me to ascertain that its branches bifurcated regularly, in the manner of *Lepidodendron*, and tapered somewhat rapidly; that its leaves were long, parallel-sided, and one-nerved; and that it produced strobile-like bodies with narrow-pointed, closely appressed scales borne on the sides of the branches. I have attempted to give a restoration of the Plant, from several specimens in my possession, in Pl. XVIII. fig. 19. The other characters of the genus, and the points in which it differs from *Lepidodendron* and *Ulodendron*, are stated in my former paper.

9. LYCOPODITES COMOSUS, spec. nov. Pl. XVII. fig. 14.

Stem short, not observed to branch, densely covered with long filiform leaves.

This little Plant, of which several specimens, all equally diminutive, were found, somewhat resembles *Selaginites Erdmanni* of Germany, but is smaller and differently proportioned.

10. CORDAÏTES (PYCHNOPHYLLUM) FLEXUOSUS, spec. nov. Pl. XVII. fig. 9.
Leaves lanceolate, acuminate, broad at the base; nerves numerous, parallel, somewhat sinuous and uneven.

A number of more or less perfect specimens of this leaf were found. It has the general appearance of the leaves of *Cordaïtes*; but less distinct venation, and apparently less rigidity than the other species. I place it in this genus merely provisionally, as its true affinities are, of course, quite uncertain.

11. CYCLOPTERIS JACKSONI, Dawson. Pl. XIX. fig. 26.

This is by far the most abundant species at Perry, and a large number of specimens were obtained. One of these shows that the full-grown frond was a foot in length, with a strong woody rugose petiole a quarter of an inch thick at the base. Some of these petioles in a pyritized state show traces of scalariform vessels. Old stipes deprived of their leaves very closely resemble the *Rhachiopteris pinnata* of the Marcellus shale of New York, though not quite so large, and perhaps more rugose. Among the numerous scattered pinnæ of this species there are some of much smaller size than the others, which may possibly indicate a distinct species; but, for the present, I am rather disposed to regard them as merely a variety. (See Pl. XIX. fig. 26, c.)

I also found a few detached pinnules, which I believe to belong to *Cyclopteris Halliana*, of the Chemung group of New York. I have attempted to represent the characteristic forms of the ordinary varie-

ties of *C. Jacksoni* and of *C. Halliana* in Pl. XIX. figs. 26 & 28. I may add here that the stipe of *Cyclopteris Jacksoni* has a few leaves between the pinnules of the upper part, but is less leafy than that of *C. Halliana*.

12. *CYCLOPTERIS ROGERSI*, spec. nov. Pl. XVII. figs. 17, 18; and Pl. XIX. fig. 27.

Habit of growth resembling that of Cyclopteris Jacksoni, but the pinnules are more elongated and almost cuneate in form, also less densely placed, and with veins more nearly parallel. Stipe stout, woody, furrowed longitudinally, and marked with strong transverse bars or punctures.

This Fern is less abundant than *C. Jacksoni*, from which the points above mentioned appear sufficient to distinguish it. Its stipe is marked in the manner of *Rhachiopteris punctata* of the Chemung group of New York, and of *C. Roemeriana*, Goeppert, from the Upper Devonian of Europe; of the latter species the present may be regarded as the American representative. I have endeavoured, from the small fragments collected, to give characteristic representations of the appearance of the species. It was probably about the same size as *C. Jacksoni*, but with its stipe not leafy, and its pinnae and pinnules less densely placed.

It would seem that the remarkable group of pinnate *Cyclopterides*, to which this species belongs, was characteristic of the Upper Devonian throughout North America and Europe. I dedicate the present member of it to Prof. W. B. Rogers, who has done much to direct attention to the deposits of Perry, and has kindly permitted me to use the specimens in his collection.

13. *CYCLOPTERIS BROWNII*, Dawson. Pl. XVII. fig. 6.

This fine species, described in my former paper from a mere fragment of a frond, I am now able to figure in its full dimensions, from a fine specimen in the collection of Prof. Rogers of Boston; several others, nearly as perfect, were found by Mr. Brown and myself last summer. It has a large simple frond, flabellate in form and divided toward the edges, which are sometimes slightly reflected, as if they had borne marginal fructification. It belongs to the group of simple-leaved *Cyclopterides*, like *C. orbicularis*, Brongn., of the Coal-measures, or *C. digitata* and *C. Huttoni* of the Oolite. It very closely resembles a beautiful leaf from the Ponent (Upper Devonian) of Pennsylvania, figured, but not named, by Prof. H. D. Rogers in his Report on the Geology of that State (vol. ii. pt. 2. pl. 22). This resemblance did not appear from my imperfect specimen of last year; but I can scarcely now doubt that Prof. Rogers's Plant is the same, or very closely allied. The leaf from Pennsylvania was compared by Prof. Balfour, to whom it was submitted by Prof. Rogers, with that of *Salisburyia adiantifolia*, to which it unquestionably bears a strong resemblance; and it may admit of doubt whether it is really a Fern or a coniferous leaf. In the absence of fructification it may be impossible to decide this question; but the form and texture of

the leaf appear to me more those of a Fern, possibly allied to *Adiantum* or *Lindsaea*.

14. SPHENOPTERIS RECURVA, spec. nov. Pl. XVII. figs. 7 & 8.

Leaflets small, cuneate, terminating the divisions of a dichotomous winged petiole.

This Plant is represented by small and obscure fragments on the Perry sandstone. Its venation is not preserved; and it may be a small *Cyclopteris* with terminal pinnules, like my *C. Acadica*, from the Lower Coal-formation of Nova Scotia.

15. TRICHOMANITES FILICULA, spec. nov. Pl. XVII. figs. 12 & 13.

Pinnules slender, attached to long petioles, and bifurcating into slender points.

This species approaches *T. Beinertii* and *T. adnascens*, and there are indications that, like the latter, it may have been parasitic on petioles or branches of other Plants. Numerous specimens occur at Perry, but all are small and somewhat obscure.

16. FILICES INCERTÆ SEDIS. Pl. XVII. figs. 10 & 16.

Among the Plants collected by Mr. Brown are two somewhat obscure examples of the frond or pinnule represented in Pl. XVII. fig. 10. It is of a linear form, with crenations or teeth on the margins. The midrib is delicate; the nerves, which are rather indistinct, appear to be netted near the midrib in the manner of *Glossopteris*, Brongn.; but they are distinct toward the margin, where there are, in the sinuses of the teeth, dark spots, which are probably remains of fructification. These evidences of marginal fructification remove the Plant entirely from *Glossopteris*; and I am not aware of any other genus of fossil Ferns in which it could be placed. It may have been allied to such recent genera as *Lonchitis* or *Hypolepis*. The specimens are, however, so imperfect and obscure, that I content myself in the meantime with representing what I can make out of their form and venation, trusting that they may at some future time be named from more perfect examples.

The frond or pinnule shown in Pl. XVII. fig. 16 represents another uncertain species. It is cuneiform in shape and broad at the base in all the specimens that I have seen. It has not been found attached to a stem or petiole. Its venation is less coarse than that of *Cyclopteris Brownii*, and much coarser than that of *C. Rogersi* or *C. Jacksoni*. It approaches also more nearly to parallelism, and seems less forked. This leaf would go into the genus *Noeggerathia* of some authors, and may be a distinct species; but I am by no means certain that it is not a young state or marginal division of *Cyclopteris Brownii*, and hence refrain, for the present, from naming it.

17. CARPOLITHES LUNATUS, spec. nov. Pl. XVII. fig. 11.

Base rounded regularly, apex broadly truncate and mucronate; nucleus surrounded by a narrow margin.

This species is described from a single specimen, which, however, appears sufficiently well characterized.

18. CARPOLITHES? SILIQUA, spec. nov. Pl. XVII. fig. 4.

Elongate, smooth, flattened, sides slightly sinuate; two inches or less in length; a quarter of an inch or less in breadth.

These objects are too thick and carbonaceous to have been fronds or leaves, and too regular in form to be fragments of stems. They may, however, have been swollen extremities of roots.

§ III. Gaspé, Canada.

The Plants collected at Gaspé by Mr. Bell, last summer, consist principally of *Psilophyton princeps* in all states of preservation, still further illustrating the predominance of that species in the Gaspé sandstones, many parts of which were then, for the first time, explored by Mr. Bell. In addition to the facts previously known respecting this Plant, the specimens now obtained illustrate the internal structure of its creeping rhizomes, previously found only flattened or as casts. Mr. Bell has also added to the Gaspé flora *Leptophloeum rhombicum*, previously found only at Perry, and *Didymophyllum reniforme*, a Plant of the Middle Devonian of New York, thus connecting by new links the contemporary floras of these distant localities. His collection also contains two new and curious species of fossil wood, and several fragments possibly indicating new species, but at present of ambiguous character. The more important of these discoveries I indicate under the following heads.

1. PSILOPHYTON PRINCEPS, Dawson (rhizomata). Pl. XVIII. fig. 22.

Sir W. S. Logan had obtained from the marine limestones at the base of the Gaspé sandstones, constituting the lowest members of the Devonian Series, if they are not Upper Silurian, a few flattened stems, which in my paper on the Devonian Plants of Gaspé* I referred with doubt to *Psilophyton*. Mr. Bell has collected many additional specimens, some of them perfectly flattened, and which, but for obscure remains of the surface-markings, might readily be mistaken for *Algae*; others retain more or less perfectly their cylindrical form. The latter are all rhizomata, usually about half an inch in diameter, and retain the structures of the outer bark and internal axis in a calcified state, the cell-walls being changed into coaly matter. The outer bark is seen under the microscope to consist of cellular tissue, dense toward the surface, and more lax within, as seen in a transverse section; while in the longitudinal section the outer portion is found to consist of cells elongated in the manner of bast-tissue, and the inner of ordinary parenchymatous cells. The thick inner bark, which was probably of lax cellular tissue, has disappeared. The slender cylindrical axis consists of woody fibres externally, and of scalariform vessels within; it has a vacant space of very small size in the centre, which may represent a pith, but is perhaps merely a result of decay and shrinking, which have caused the vascular bundle to separate from the woody sheath, and the fibres of the latter to separate in such a manner as to present very

* Quart. Journ. Geol. Soc. vol. xv.

different aspects in different parts of the axis of the same rhizome. This structure, it may be observed, corresponds perfectly with that of the aerial stem of the same Plant, illustrated in my paper on the Devonian Plants of Gaspé, the differences being merely those which might have been anticipated from the greater size of the rhizome, and its probably subaquatic or subterranean character. I have endeavoured, in Pl. XVIII. figs. 22*a* to 22*g*, to represent the structures above described, which, with what was previously known, almost complete our knowledge of this interesting Plant.

It is further interesting to observe that *Psilophyton princeps* has now been found to extend from the very bottom of the Devonian series to its upper members, and throughout every part of Eastern America in which land-plants have been found in these beds. That it has not been recognized in Europe I attribute to its want of decided external characters, when in an imperfect state of preservation, having caused it to be mistaken for Algæ, roots, &c. Similar views might have prevailed here, but for the vast profusion of these Plants found *in situ* in Gaspé, and the admirable preservation both of their external markings and internal structure.

2. NEMATOTAXYLON CRASSUM, gen. et spec. nov. Pl. XIX. fig. 24.

Fragments of wood with a smooth thin bark, and a tissue wholly composed of elongated cylindrical cells with irregular pores or markings. No pith, medullary rays, nor rings of growth.

The specimens to which the above description refers are fragments, the largest of which may have been 2 inches long, an inch wide, and half an inch thick. They present under a magnifying-glass a fibrous appearance (as if made up of thin threads or wires), from which I have taken the name of the genus. They are calcified, and when sliced show their structures very perfectly. Under the microscope they at first sight remind the observer of the structure of *Prototaxites*; but the cells are of one-third greater diameter than in *P. Loganii*, and are destitute of its peculiar markings, and there are no rings of growth or medullary rays. The wood-cells are of great length, somewhat tortuous, loosely aggregated, and much thickened by ligneous deposit, which appears to be traversed by many narrow tortuous lines or pores. The whole stem seems to be perfectly homogeneous, and the only other structure observed was a faint and doubtful trace of the existence of parenchymatous cells in some of the spaces between the fibres. The figures show a longitudinal and cross section, magnified, and a few detached cells or woody fibres still more highly magnified.

With respect to the affinities of this tissue, I can give no opinion. It may have been that of a Plant whose stem, destitute of true vessels and composed of woody fibres imbedded singly in cellular tissue, bore the same relation to that of an Endogen which *Prototaxites* bears to an ordinary Exogen. On the other hand, it has a sufficiently strong resemblance to the fibrous outer bark of some *Sigillariæ* to render it possible that it may have belonged to a Plant of this character, of which the axis and inner bark have perished.

3. NEMATOSYLON TENUE, spec. nov. Pl. XVIII. fig. 23.

Slender stems with thick coaly bark, and woody fibres of much smaller diameter than in the last species, and marked with minute dots.

The stems of this species are small, not exceeding half an inch in diameter, but are distinctly surrounded by a thick, shining, coaly bark. The wood is calcified, and appears to be perfectly homogeneous, and composed of the tissue represented in Pl. XVIII. figs. 23 *a* to 23 *c*, the last two of which are drawn to the same scale as fig. 24 *b*, to show the different dimensions of the cells. It may be doubted if this species has any real affinity with the last, but they correspond in their negative characters, and both appear to indicate the existence of certain woody Plants of singularly simple and homogeneous structure. Many of the small carbonized fragments scattered over the surfaces of the Gaspé sandstones belong to the present species, and were noticed in my former paper on the Plants of Gaspé as aporous tissues of uncertain nature.

4. INCERTÆ SEDIS.

Among Mr. Bell's specimens are many fragments of quite uncertain character. One of these is a stem thickly studded with minute irregularly placed points or tubercles, and having a finely striated surface (Pl. XIX. fig. 25). It resembles the "branching root" figured by Mr. Salter from the Devonian of Stromness. Another is a stem with interrupted ridges, in the manner of *Rhachiopteris striata* from the Devonian of New York, fig. 31. It may be the stipe of a Fern. Another (fig. 29) is a very slender stem marked with minute raised scales or rudimentary leaves, and possibly a *Lycopodites* of the type of *L. Milleri*, Salter. To these I have added, from my own collection, a little Stigmarioid Plant, fig. 31, which, if really a *Stigmaria*, is the most diminutive of the genus; but it may admit of doubt whether it is not an imperfectly preserved Lepidodendroid Plant.

5. ALGÆ. Pl. XIX. figs. 32 & 33.

In Mr. Bell's collection are numerous specimens, apparently of Sea-weeds, resembling the Cauda-galli Fucoid of the Devonian rocks of New York. They appear to include two distinct forms. One of these (fig. 32) consists of cylindrical and dichotomous filaments, and may be referred to the provisional genus *Chondrites*. It appears to be the first or fibrous form of *Fucoides Cauda-galli* mentioned by Vanuxem (Report, p. 128, fig. 30). The other (fig. 33) is a continuous frond, and shows indications of having been thickened or folded at the convex margin. It might be placed in the genus *Zonarites*, and is probably identical with Vanuxem's second or continuous form, for which he proposes the name *Fucoides velum*. Both occasionally appear as if looped or attached at both extremities, as was the case in Vanuxem's specimens. The first-mentioned species, or variety, is found in beds believed to be Upper Silurian, and which contain obscure remains of Land-plants, at Aune à la Barbe in the

Baie de Chaleurs. The second is also from rocks at Gaspé*, supposed to be Upper Silurian, but below those containing Land-plants.

§ IV. *New York.*

In my paper of last year several species were referred to the Catskill group, being so labelled in the collection of the Geological Survey of New York. Prof. Hall has, however, communicated to me, and published in the 'Canadian Naturalist,' observations recently made by Mr. Way and others, and confirmed by his own examinations, of sections and fossils, which show that the rocks from which these Plants were obtained really belong to the underlying Portage and Chemung groups. This brings the distribution of the Devonian Plants of New York more nearly into harmony with that observed at Gaspé and elsewhere, and leaves the Catskill group, as now restricted, destitute of that evidence of connexion with the underlying beds which these Plants seemed to afford.

I desire to change the name *Pecopteris (Alethopteris) decurrens*, of my last paper, into *P. discrepans*†,—a species from the Coal of Pennsylvania having been described by Lesquereux under the former name.

§ V. *Conclusion.*

The present paper raises the number of species obtained from the Devonian rocks of Eastern America to about eighty-two, but does not in any respect invalidate the general conclusions stated in my former paper. Of the whole number of species, only two can with certainty be referred to the Lower Devonian, and these also occur higher in the series. Twenty-one are found in the Middle Devonian, and of these nine or ten ascend to the Upper Devonian, which has afforded about sixty-eight species; and of these probably ten are known in the Carboniferous System. It must be observed, however, that the precise age of the beds at Perry and St. John is uncertain, and that they are referred to the Upper Devonian principally on the evidence of their fossil Plants,—the stratigraphical evidence being sufficient merely to prove their Precarboniferous date.

EXPLANATION OF PLATES XVII.-XIX.

PLATE XVII.

- Figs. 1 & 2. Portions of pinnae of *Lycopodites Richardsons*; (2 a) leaves enlarged.
 3. *Stigmaria pusilla*.
 4. *Carpolithes? siliqua*.

* Prof. Hall informs me that he has ascertained the ordinary *Fucoides Caudagalli* of New York to be fragments of spiral forms, which he proposes to describe, under a new generic name, in a forthcoming Report of the Regents of the University of New York. It is possible that the Gaspé fucoids above noticed may also have been spiral in their growth.

† This correction has already been made in the list of errata occurring in vol. xviii. of the Society's Journal, and published, together with the title-page and index of that volume, with No. 73 of the Journal.—EDR.

Figs. 5. Fragment of root of Conifer.

6. Portion of pinna of *Cyclopteris Brownii*; (6 a) stipe of *C. Jacksoni*.

7 & 8. *Sphenopteris recurva*.

9. *Cordaites flexuosus*.

10. Pinna of a Fern, not named; (10 a) portion magnified.

11. *Carpolithes lunatus*.

12 & 13. *Trichomanites filicula*.

14. *Lycopodites comosus*; (14 a) portion magnified.

15. *Carpolithes spicatus*.

16. Fern, not named.

17. Pinna of *Cyclopteris Rogersi*.

18. Stipe of *Cyclopteris Rogersi*.

PLATE XVIII.

Fig. 19. *Leptophleum rhombicum*, restored; (19 a) leaf.

20. Fragment of bark of Conifer.

21. *Anarthrocanna Perryana*.

22. Rhizoma of *Psilophyton princeps*; (22 a) cross section of the same, showing the axis and bark; (22 b) portion of cross section magnified, showing remains of the bark β , of inner bark ϵ , of the woody sheath of the axis γ , of the scalariform centre of the axis δ ; (22 c) cross section of the tissue of the axis, magnified 100 diameters; (22 d) longitudinal section of the tissue of the axis; (22 e) cross section of the outer bark; (22 f) longitudinal section of the axis of the aerial stem for comparison with e; (22 g) cross section of the axis of another specimen, magnified as in c.

23. Portion of the stem of *Nematoxylon tenue*; (23 a) cross section slightly enlarged; (23 b) longitudinal section; (23 c) transverse section, magnified 200 diameters.

PLATE XIX.

Fig. 24. Longitudinal section of the stem of *Nematoxylon crassum*, magnified 100 diameters; (24 a) cross section; (24 b) transverse section of a few cells, magnified 200 diameters.

25. Stem with tubercles; (25 a) magnified.

26. Pinna of *Cyclopteris Jacksoni*; (26 a) separate pinnule; (26 b) diagram of venation; (26 c) small variety.

27. Pinna of *Cyclopteris Rogersi*; (27 a) separate pinnule; (27 b) diagram of venation.

28. Pinna of *Cyclopteris Halliana*; (28 a) separate pinnule; (28 b) diagram of venation.

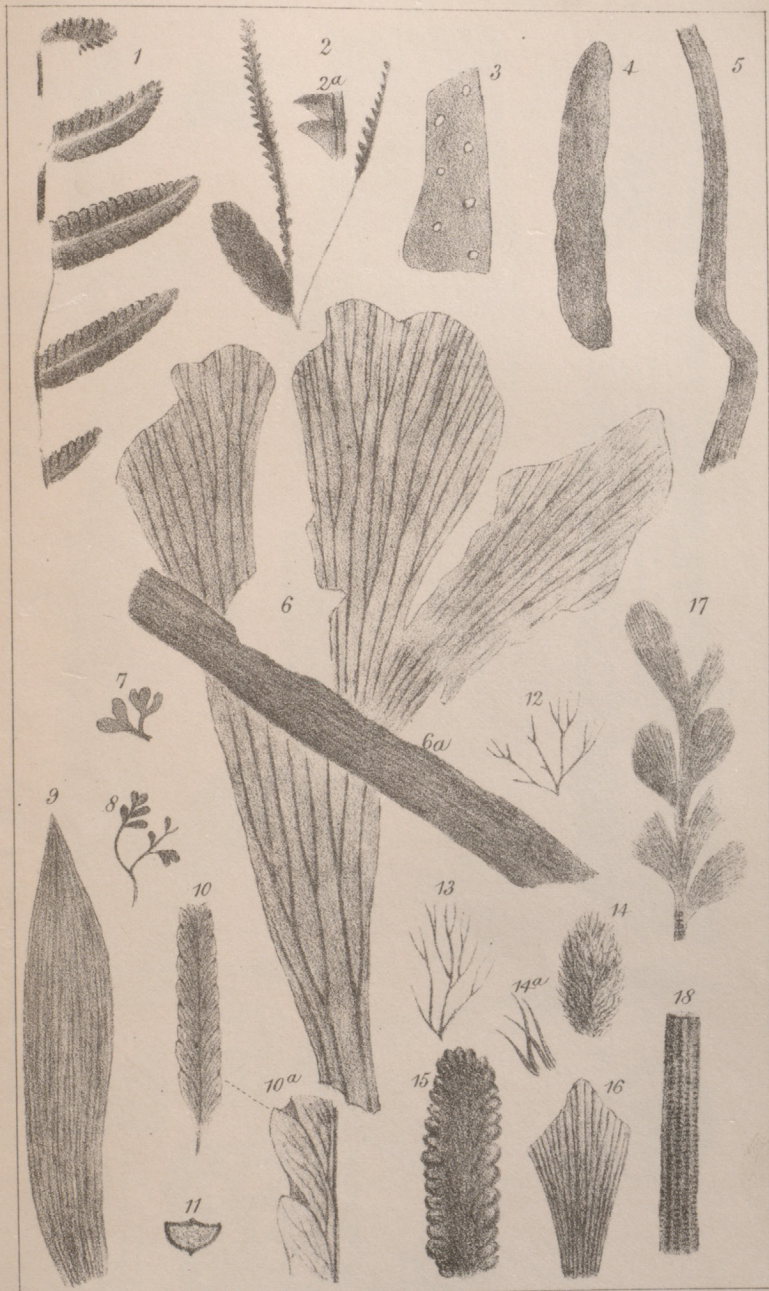
29. *Lycopodites*.

30. Stem with ridges.

31. *Stigmaria*?; (31 a) areole magnified.

32. *Fucoides* (*Chondrites*) *Cauda-galli* (reduced).

33. *Fucoides* (*Zonarites*) *velum* (reduced).



J.W.D. del. G. West lith.

W. West imp.

DEVONIAN PLANTS, N.E. AMERICA.



J.W.D. del. G. West lith.

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4

ON THE
CONDITIONS
OF THE
DEPOSITION OF COAL,
MORE ESPECIALLY AS ILLUSTRATED
BY THE
COAL-FORMATION OF NOVA SCOTIA
AND
NEW BRUNSWICK.

BY
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PRINCIPAL OF M'GILL COLLEGE, MONTREAL.

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§ I. INTRODUCTION.

IN several former papers presented to this Society, I have endeavoured to illustrate the arrangement of the Carboniferous rocks of Nova Scotia, and to direct attention to their organic remains, the structures found in their coals, and the evidence which they afford as to the mode of accumulation of that mineral. The present paper is intended as the summing up and completion of these researches, with the addition of the new facts resulting from a careful study of the microscopic structure of more than seventy beds of coal occurring in the South-Joggins section, and of the fossil plants associated with them. These results will, I hope, throw much additional light on some of the more difficult problems connected with the theory of the accumulation of vegetable matter in the Carboniferous period, and its conversion into coal.

The subjects to which I propose to direct attention may be conveniently arranged under the following heads:—

(1) General considerations relating to the physical conditions of the Carboniferous period in Nova Scotia.

(2) Details of the character and contents of the several beds of coal in the Joggins section, arranged in the order of Logan's Sectional List.

(3) Remarks on the genera of animals and plants whose remains occur in the coal, and on their connexion with its accumulation.

§ II. GENERAL CONSIDERATIONS RELATING TO PHYSICAL CONDITIONS.

1. *Physical Characters of the several Coal-formations.*—The total vertical thickness of the immense mass of sediment constituting the Carboniferous system in Nova Scotia may be estimated from the fact that Sir W. E. Logan has ascertained by actual measurement at the Joggins a thickness of 14,570 feet; and this does not include the lowest member of the series, which, if developed and exposed in that locality, would raise the aggregate to at least 16,000 feet. It is certain, however, that the thickness is very variable, and that in some districts particular members of the series are wanting, or are only slenderly developed. Still the section at the Joggins is by no means an exceptional one, since I have been obliged to assign to the Carboniferous deposits of Pictou, on the evidence of the sections exposed in that district, a thickness of about 16,000* feet; and Mr. Brown has estimated the Coal-formation of Cape Breton, exclusive of the Lower Carboniferous, at 10,000 feet in thickness†.

When fully developed, the whole Carboniferous series may be arranged in the following subordinate groups or formations, the limits of which are, however, in most cases not clearly defined:—

a. *The Upper Coal-formation.*—It consists of sandstones, shales, and conglomerates, with a few thin beds of limestone and coal. *Calamites Suckowii*, *Annularia galioides*, *Cordaites simplex*, *Alethopteris nervosa*, *Pecopteris arborescens*, *Dadoxylon materiarium*, *Lepidophloios parvus*, and *Sigillaria scutellata*, are among its characteristic vegetable fossils.

* Quart. Journ. Geol. Soc. vol. i. p. 329.

† *Ibid.* vol. vi. p. 116.

b. *The Middle Coal-formation, or Coal-measures proper.*—This series includes the productive beds of coal, and is destitute of properly marine limestones. Beds tinged with peroxide of iron are less common in this formation than in any of the others. Dark-coloured shales and grey sandstones prevail, and there are no conglomerates. *Sigillaria* and *Stigmaria* of many species are the most conspicuous and abundant fossils, but Ferns, *Cordaites*, and *Calamites* are also extremely abundant, and all the genera of Carboniferous plants are represented. Many beds, especially those in the vicinity of layers of coal, contain minute *Entomostraca*, shells of the genus *Anthracomya* (*Naiadites*), *Spirorbis carbonarius*, and remains of ganoid and placoid fishes.

c. *The "Millstone-grit" Formation.*—This name, though not in all cases lithologically appropriate, has been borrowed from English geology to designate the group of sandstones, shales, and conglomerates, destitute of coal, or nearly so, and with few fossil plants, which underlies the Coal-measures. In its upper and middle part it includes thick beds of coarse grey sandstone holding prostrate trunks of coniferous trees (*Dadoxylon Acadianum*). In its lower part red and comparatively soft beds prevail.

d. *The Lower Carboniferous Marine Formation.*—The essential features of this formation are thick beds of marine limestone, characterized principally by numerous Brachiopods, especially *Productus Cora*, *P. semireticulatus*, *Athyris subtilita*, and *Terebratula sufflata**, with other marine invertebrates. Associated with these limestones are beds of gypsum, and they are enclosed in thick deposits of sandstone, clay, and marl, of prevailing red colours.

e. *The Lower Carboniferous Coal-measures, or Lower Coal-measures.*—In some localities these resemble in mineral character the true Coal-measures. In others they present a great thickness of peculiar bituminous and calcareous shales. They usually contain in their lower part thick beds of conglomerate, and coarse sandstone which in some places prevail to the exclusion of the finer beds. The characteristic plants of these beds are *Lepidodendron corrugatum*, and *Cyclopteris Acadica*, with *Dadoxylon antiquius*, and *Alethopteris heterophylla*†. They also contain locally great quantities of remains of fishes, and many Entomostracans, among which are *Levia Leidyi* and an *Estheria*, also *Leperditia subrecta*, Portlock, *Beyrichia colliculus*, Eichw., and a *Cythere*‡, probably new.

The last two groups are equivalent to the "Sub-carboniferous" of some American geologists; but independently of the objection to the use of a term which would seem to imply a formation under, and distinct from, the Carboniferous, and of undetermined age, I find in Nova Scotia no reason, either palæontological or stratigraphical, for any greater distinction than that implied in the term Lower

* See Davidson "On Lower Carboniferous Brachiopoda from Nova Scotia," Quart. Journ. Geol. Soc. vol. xix. p. 158.

† Dawson, "On the Lower Coal-measures," &c., Quart. Journ. Geol. Soc. vol. xv. p. 62.

‡ Prof. Jones has kindly determined these species.

Carboniferous. The Lower Coal-measures are, it is true, more distinct in their flora from the Middle Coal-measures than the latter from the Upper Coal-formation; but still many species are common to the two former, and the difference is small as compared with that between the Lower Carboniferous and the Upper Devonian. The Devonian rocks are also in this region unconformable to the Carboniferous, having been disturbed and altered prior to the deposition of the latter; while no want of conformity, except of the local character hereafter to be noticed, occurs in the Carboniferous.

2. *Physical Conditions attending the Deposition of the Coal-formations.*—The conditions of deposit implied in the mineral character of the several formations above described, would appear to be of three leading kinds:—(1) The deposition of coarse sediment in shallow water, with local changes leading to the alternation of clay, sand, and gravel. This predominates at the beginning of the period, recurs after the deposition of the marine limestones in the formation of the "Millstone-grit," and again prevails in the Upper Coal-formation. (2) The growth of corals and shellfish in deep clear water, along with the precipitation of crystalline limestone and gypsum. These conditions occurred during the formation of the Lower Carboniferous Limestone and its associated gypsum. (3) The deposition of fine sediment, and the accumulation of vegetable matter in beds of coal and carbonaceous and bituminous shale, and of mixed vegetable and animal matters in the beds of bituminous limestone and calcareo-bituminous shale. These conditions were those of the Middle Coal-formation.

Within the limits of Nova Scotia, these conditions of deposition applied, not to a wide and uninterrupted space, but to an area limited and traversed by bands of Silurian and Devonian rocks, already partially metamorphosed and elevated above the sea, and along the margins of which igneous action still continued, as evidenced by the beds of trap intercalated in the Lower Carboniferous*; while about the close of the Devonian period still more important injections and intrusions of igneous matter had occurred, as shown by the granitic dykes and masses which traverse the Devonian beds, but have not penetrated the Carboniferous†. There is evidence, however, in the Carboniferous rocks of the Magdalen Islands and of Newfoundland, and in the fringes of such rocks on parts of the coast of Nova Scotia‡ and New England, that the area in question was only a part of a far more extensive region of Carboniferous deposition, the greater part of which is still under the waters of the Atlantic and of the Gulf of St. Lawrence.

There is ample proof that most of the coarser matter of the Carboniferous rocks was derived from the neighbouring metamorphic ridges; but much of the finer material was probably drifted from more distant sources. There seems no good reason to doubt that in the Carboniferous period, and especially in those portions of it in

* Dawson, Quart. Journ. Geol. Soc. vol. i. p. 329.

† Dawson, Canadian Naturalist, 1860, p. 142.

‡ Jukes's 'Newfoundland,' Acad. Geology, p. 274.

which the areas now under consideration were in the condition of shallow seas or swampy flats, the greater part of the Laurentian and Silurian districts of North America existed as land; while the great number of Coal-formation plants common to Europe and America may indicate the existence of intermediate lands now submerged. From such lands, undergoing waste during the long Carboniferous time, the materials of the shales and finer sandstones may have been derived.

Taking this view of the source of the sediment, we should infer that the time of the formation of the marine limestones was that of greatest depression of the land, when the local ridges of older rock were mere reefs and islets, and when sediment from more distant lands was deposited only at intervals. We should also infer that the time of the formation of the coal-beds was that of greatest elevation, when the former sea-bottoms had become land-surfaces or flats, exposed only to occasional inundation, and when rivers were bearing downward from large continental regions great quantities of fine silt. Further, the conditions of the Millstone-grit and of the Newer Coal-formation must have been of an intermediate character, requiring wide sea-areas receiving great quantities of sediment, and on this account, as well as because of their shallowness, unfavourable to marine life, while the areas of vegetable growth were also of limited extent.

It would also follow that when the Lower Coal-measures and conglomerates were formed, the land was slowly subsiding; that in the time of the marine limestones it attained to its greatest depression, and long remained nearly stationary; that in the Millstone-grit period there was re-elevation, and that in the period of the Middle Coal-formation and Newer Coal-formation there was again subsidence, slow and interrupted at first, but subsequently of greater amount. From the absence of Permian deposits it may be inferred that elevation again took place at the close of the Carboniferous period, to such an extent as to preclude further deposition in the area in question; while the red sandstone and trap of Mesozoic age indicate the recurrence at that time of conditions somewhat similar to those of the beginning of the Carboniferous period.

The general phenomena of deposition above indicated apply to all the Carboniferous areas of Nova Scotia and New Brunswick, and, so far as known, to those of the Magdalen Islands and of Newfoundland. But, as I have pointed out in 'Acadian Geology,' numerous local diversities occur, in consequence of the interference of the older elevated ridges with the regularity of deposition. In some places the entire Lower Carboniferous series seems to be represented by conglomerates and coarse sandstones. In others, the Lower Coal-measures, or the Marine Limestones, or both, are extensively developed. These local differences are, on a small scale, of the same character with those which occur on a large scale in the Northern and Southern Appalachian districts and Western districts of the United States, and in the different coal-areas of Great Britain and Ireland, as compared with each other and with the Carboniferous districts of

America. On the whole, however, it is apparent that certain grand features of similarity can be traced in the distribution of the Carboniferous rocks throughout the northern hemisphere.

It is further to be observed that in Nova Scotia and New Brunswick, as well as in Eastern Canada, disturbances occurred at the close of the Devonian period which have caused the Carboniferous rocks to lie unconformably on those of the former; and that in like manner the Carboniferous period was followed by similar disturbances, which have thrown the Carboniferous beds into synclinal and anticlinal bends, often very abrupt, before the deposition of the Triassic Red Sandstones. These disturbances were of a different character from the oscillations of level which occurred within the Carboniferous period. They were accompanied by volcanic action, and were most intense along certain lines, and especially near the junction of the Carboniferous with the older formations.

I have noticed an apparent case of unconformability between members of the Carboniferous system near Antigonish*. In the county of Pictou the arrangement of the beds suggests a possible unconformability of the Upper Coal-formation and the Coal-measures†. In New Brunswick Prof. Bailey‡ has observed indications of local unconformability of the Coal-formation with the Lower Carboniferous. But the strict conformability of all the members of the Carboniferous series in the great majority of cases, shows that these instances of unconformability are exceptional. In the section at the Joggins, more especially, the whole series presents a regular dip, diminishing gradually from the margin to the middle line of the trough, where the beds become horizontal.

The most gradual and uniform oscillations of level must, however, be accompanied with irregularities of deposition and local denudation; and phenomena of this kind are abundantly manifest in the Carboniferous strata of Nova Scotia. I have described in 'Acadian Geology' a bed in the Pictou coal-field which seems to be an ancient shingle-beach, extending across a bay or indentation in the coast-line of the Carboniferous period§. At the Joggins many instances occur of the sudden running out and cutting off of beds||, and Mr. Brown has figured a number of instances of this kind in the Coal-formation of Sydney¶. They are of such a character as to indicate the cutting action of tidal or fluvial currents on the muddy or sandy bottom of shallow water. In some instances the layers of sand and drift-plants filling such cuts suggest the idea of tidal channels in an estuary filled with matter carried down by river-inundations. Even the beds of coal are by no means uniform when traced for considerable distances. The beds which have been mined at Pictou and the Joggins show material differences in quality and associations; and small beds may be observed to change in a remarkable manner, in

* Quart. Journ. Geol. Soc. vol. i. p. 32.

† *Ibid.* vol. x. p. 42; Acadian Geology, p. 249.

‡ Report on Geology of Southern New Brunswick, p. 118.

§ Quart. Journ. Geol. Soc. vol. x. p. 45.

|| *Ibid.* vol. x. p. 12.

¶ *Ibid.* vol. vi. p. 125 *et seq.*

their thickness and in the materials associated with them, in tracing them a few hundreds of feet from the top of the cliff to low-water mark on the beach. I have no doubt that, could we trace them over sufficiently large areas, they would all be found to give place to sandstones, or to run out into bituminous shales and limestones, according to the undulations of the surfaces on which they were deposited, just as the peaty matter in modern swamps thins out toward banks of sand, or passes into the muck or mud of inundated flats or ponds.

3. *Geological Cycles*.—The foregoing considerations bring, in a very distinct manner, before us two different, and at first sight irreconcilable, general views which we may take of any given geological period. *First*, we must regard every such period as presenting during its whole continuance the diversified conditions of land and water with their appropriate inhabitants; and *secondly*, we must consider each such period as forming a geological cycle, in which such conditions to a certain extent were successive. As we give prominence to one or the other of these views, our conclusions as to the character of geological chronology must vary in their character; and in order to arrive at a true picture of any given time, it is necessary to have both before us in their due proportion.

We know that the marine animals of the Lower Carboniferous seas continued to exist in the time of the Coal-formation, and that some of them survived until the Permian period, proving to us the existence of deep seas even in that age which we regard as specially characterized by swampy flats supporting land-plants. In like manner we know that some of the species of land-plants found in the lowest Coal-measures continued to exist in the time of the Upper Coal-formation, proving that there was some land suitable for them throughout the epoch of the deep-sea limestones. Regarded from this point of view, any exceptional beds with land-plants in the marine parts of the formation, or beds with sea-shells in the parts where land-conditions predominate, acquire a special interest; and so likewise do regions in which, as in some parts of the Appalachian Coal-field, the marine limestones are absent, and those in which, as in some parts of the Western States, marine conditions seem to have continued throughout the whole period. In Nova Scotia, so far as my present knowledge extends, the marine limestones of the Lower Carboniferous cut off the flora of the Lower Coal-measures, apparently by a long interval of time, from that of the Middle Coal-formation; and in like manner the fossils of the marine limestones cease at the time of the Millstone-grit, and only in one instance, that of a small bed of limestone near Wallace Harbour, partially reappear in the Upper Coal-formation*. I have, however, ascertained that the Marine Limestones may be divided into an upper and a lower member, and that there is some reason to suppose that in some parts of Nova Scotia, where the true Coal-measures are not developed, the upper member may in part, at least, represent them†.

* Acad. Geol. p. 183; Quart. Journ. Geol. Soc. vol. ii. p. 133.

† Quart. Journ. Geol. Soc. vol. xv. pp. 63 *et seq.* My friend Mr. C. F. Hartt, who

On the other hand, I have not as yet been able to bridge over the gulf which separates the flora of the Lower Carboniferous Coal-measures from that of the Middle Coal-formation, an interval which may include much of the "Lower Coal-measures" of Rogers in the Pennsylvania Coal-field.

Turning to that broader view which takes the prevalent conditions of each portion of the period as characteristic, notwithstanding the local existence of dissimilar conditions, we not only find, as already stated, that the sequence in Nova Scotia coincides generally with that in other parts of America and in Europe, but that, viewed in this aspect, the Carboniferous period constitutes one of four great physical cycles, which make up the Palæozoic age in Eastern America—and each of which was characterized by a great subsidence and partial re-elevation, succeeded by a second and very gradual subsidence. Viewed in this way, the Lower Carboniferous conglomerate and Lower Coal-measures correspond analogically with the Oriskany Sandstone, the Oneida and Medina Sandstones, and the Potsdam and Calciferous. The Carboniferous Limestone corresponds with the Corniferous Limestone, the Niagara Limestone, and the Trenton group of limestones. The Coal-measures correspond with the Hamilton group, the Salina group, and the Utica Shale. The Upper Coal-formation corresponds with the Chemung, the Lower Helderberg, and the Hudson-River groups. The Permian is not represented in Eastern America; but as developed in Europe it clearly constitutes a similar cycle. These parallelisms, which deserve more attention from geologists than they have yet received, may be tabulated thus*:

Tabular View of Cycles in the Palæozoic Age in Eastern America.
(The several formations are arranged in descending order.)

Character of group.	Lower Silurian.	Upper Silurian.	Devonian.	Carboniferous.
Shallow, subsiding marine area, filling up with sediment	Hudson-River group.	Lower Helderberg group.	Chemung gr. . .	Upper Coal-formation.
Elevation, followed by slow subsidence, land-surfaces, &c.				
Marine conditions; formation of limestones, &c. . .	Utica shale ..	Salina group. .	Hamilton gr. . .	Coal-measures.
Subsidence; disturbances; deposition of coarse sediment	Trenton, Black R. and Chazy limestones.	Niagara and Clinton limestones.	Corniferous limestone.	Lower Carboniferous limestone.
	Potsdam and Calciferous sandstones.	Oneida and Medina sandstones.	Oriskany sandstone.	Lower Coal-measures and conglomerate.

In the Permian of Europe, the Stinkstein, the Rauchwacke, the Zechstein, and the Rothliegendes might form a fifth parallel column.

has more recently studied the Marine Limestones, has obtained facts which seem to indicate the possibility of a more minute subdivision than any hitherto attempted of these beds.

* Dr. Sterry Hunt has directed attention to them in a paper "On Bitumens," 'Silliman's Journal' [2], xxxv. p. 166, and in the 'Geology of Canada,' 1863, p. 627; and Dana refers to them in his 'Manual of Geology.' Eaton and Hall had previously noticed these parallelisms.

Of course such parallelism might be variously expressed by reckoning a smaller or larger number of groups. Independently of these different modes of statement, however, I believe that the basis of such comparisons exists in nature, and that it will prove possible to subdivide geological time into determinate natural cycles, the parts of which are analogous to those of similar cycles. A further question to be solved is, whether such cycles corresponded in all parts of the world, or whether, as is more likely, the earth might be divided into areas in which in each cycle elevation and subsidence were contemporaneous. So far as the present subject is concerned, I merely desire to show that the Carboniferous rocks of Nova Scotia represent a complete cycle of the earth's history, and correspond in time with the Carboniferous of Europe, and in value with the other great divisions of the Palæozoic age.

4. *Summary of facts relating to the mode of accumulation of Coal.*—With regard to the more special subject of this paper, I would rather invite attention to the details to be presented under the next head, than make any preliminary general statements. It is, however, necessary to notice here the several views which have prevailed as to the probable accumulation of coal by driftage or growth *in situ*, in water or on land. I have already, in previous publications*, stated very fully the conclusions at which I have arrived on some portions of this subject, and I would now sum up the more important general truths as follows:—(1) The occurrence of *Stigmaria* under nearly every bed of coal, proves beyond question that the material was accumulated by growth *in situ*, while the character of the sediments intervening between the beds of coal proves with equal certainty the abundant transport of mud and sand by water. In other words, conditions similar to those of the swampy deltas of great rivers are implied. (2) The true coal consists principally of the flattened bark of *Sigillarioid* and other trees, intermixed with leaves of ferns and *Cordaites*, and other herbaceous debris, and with fragments of decayed wood constituting "mineral charcoal," all these materials having manifestly alike grown and accumulated where we find them. (3) The microscopical structure and chemical composition of the beds of Cannel-coal and earthy bitumen, and of the more highly bituminous and carbonaceous shales, show them to have been of the nature of the fine vegetable mud which accumulates in the ponds and shallow lakes of modern swamps. When such fine vegetable sediment is mixed, as is often the case, with shales, it becomes similar to the bituminous limestone and calcareo-bituminous shales of the Coal-measures. (4) A few of the underclays which support beds of coal are of the nature of the vegetable mud above referred to; but the greater part are argillo-arenaceous in composition, with little vegetable matter, and bleached by the drainage from them of water containing the products of vegetable decay. They are, in short, loamy or clay soils, and must have been sufficiently above water to admit of drainage. The absence of sul-

* "On the Structures of Coal," Quart. Journ. Geol. Soc. vol. xv. Air-breathers of the Coal Period, Montreal, 1863, p. 18.

phurets, and the occurrence of carbonate of iron in connexion with them, prove that, when they existed as soils, rain-water, and not sea-water, percolated them. (5) The coal and the fossil forests present many evidences of subaërial conditions. Most of the erect and prostrate trees had become hollow shells of bark before they were finally imbedded, and their wood had broken into cubical pieces of mineral charcoal. Land-snails and galley-worms (*Xylobius*) crept into them, and they became dens or traps for reptiles. Large quantities of mineral charcoal occur on the surfaces of all the larger beds of coal. None of these appearances could have been produced by subaqueous action. (6) Though the roots of *Sigillaria* bear some resemblance to the rhizomes of certain aquatic plants, yet structurally they are absolutely identical with the roots of Cycads, which the stems also resemble. Further, the *Sigillariae* grew on the same soils which supported Conifers, *Lepidodendra*, *Cordaites*, and Ferns, plants which could not have grown in water. Again, with the exception, perhaps, of some *Pinnulariae* and *Asterophyllites*, there is a remarkable absence from the Coal-measures of any form of properly aquatic vegetation. (7) The occurrence of marine or brackish-water animals in the roofs of coal-beds, or even in the coal itself, affords no evidence of subaqueous accumulation, since the same thing occurs in the case of modern submarine forests. For these and other reasons, some of which are more fully stated in the papers already referred to, while I admit that the areas of coal-accumulation were frequently submerged, I must maintain that the true coal is a subaërial accumulation by vegetable growth on soils wet and swampy, it is true, but not submerged. I would add the further consideration, already urged elsewhere, that, in the case of the fossil forests associated with the coal, the conditions of submergence and silting-up which have preserved the trees as fossils must have been precisely those which were fatal to their existence as living plants—a fact sufficiently evident to us in the case of modern submarine forests, but often overlooked by the framers of theories of the accumulation of coal.

It seems strange that the occasional inequalities of the floors of the coal-beds, the sand or gravel ridges which traverse them, the channels cut through the coal, the occurrence of patches of sand, and the insertion of wedges of such material splitting the beds, have been regarded by some able geologists as evidences of the aqueous origin of coal. In truth, these appearances are of constant occurrence in modern swamps and marshes, more especially near their margins, or where they are exposed to the effects of ocean-storms or river-inundations. The lamination of the coal has also been adduced as a proof of aqueous deposition; but the microscope shows, as I have elsewhere pointed out, that this is entirely different from aqueous lamination, and depends on the superposition of successive generations of more or less decayed trunks of trees and beds of leaves. The lamination in the truly aqueous cannels and carbonaceous shales is of a very different character.

It is scarcely necessary to remark that in the above summary I

have had reference principally to the appearances presented by the Coal-formation of Nova Scotia, and that I have no wish to undervalue the admirable researches on this subject of Brongniart, Goeppert, Hawkshaw, Beaumont, Binney, Rogers, Lesquereux, and others, whose publications on this subject I have read with interest, and have tested in their application to the phenomena presented to me in the coal-fields of Nova Scotia. I may add that in my opinion the phenomena of the Stigmaria-underclays, to which attention was first directed by Sir W. E. Logan, furnish the key to the whole question of the origin of coal, and that the comparisons of Coal-deposits, by Sir Charles Lyell, with the "Cypress-swamps" of the Mississippi perfectly explain all the more important appearances in the Coal-formation of Nova Scotia.

§ III. DETAILS OF THE CHARACTER AND FOSSIL CONTENTS OF THE SEVERAL BEDS OF COAL, AS EXPOSED IN THE SOUTH JOGGINS SECTION.

1. *Introduction.*—Under this heading I propose to state all the facts bearing on the origin and mode of formation of the several coals, obtained either by careful study of their outcrops on the ground, or by subsequent examination, with the aid of the microscope, of specimens collected from them. I shall follow the order of the detailed section published by Sir W. E. Logan in 1845*, including the additional points observed by Sir C. Lyell and myself in 1852, and by myself in several successive visits†, but giving in minute detail only the coals and their associated roof-beds and underclays. The sandstones and shales which constitute the mechanical filling-in between the beds of coal I shall group together in the shortest possible manner, referring to the published sections above-mentioned for details. I shall, however, mention every case of the occurrence of beds holding erect trees, and of Stigmarian underclays, as well as of beds of bituminous limestone and highly carbonaceous shale. I regard the former as being truly land-surfaces, as well as the coals, and the latter as accumulations of vegetable mud or muck which imply the contemporaneous existence in their vicinity of swamps and forests.

2. *Logan's Section* (order descending). a. *Division 1.*—This extends along the coast from Shoulie River to the vicinity of Ragged Reef, being nearly horizontal at the former place and gradually assuming a decided south-west dip towards the latter. It is 1617 feet in vertical thickness, and constitutes the upper part of the "Upper Coal-formation." It occupies the centre of the great synclinal of the western part of the Cumberland coal-area, and presents the newest beds of the Carboniferous system.

The rocks are thick-bedded white and grey sandstones, passing in some places into conglomerates with quartz pebbles, and interstratified with reddish and chocolate shales. The sandstones predominate.

Fossils are not numerous in these beds. Those found are *Dadoxys*-

* Report of Progress of Canadian Survey, 1845.

† Quart. Journ. Geol. Soc. vol. x.; also *Acadian Geology*, p. 128 *et seq.*

lon materiarium, of which there are many drifted trunks in the sandstones in a blackened and calcified condition, *Calamites Suckovii*, *C. Cistii*, *Calamodendron approximatum*, *Lepidodendron undulatum*, *Lepidophloios parvus*, and *Stigmaria ficoides*. As in the Upper Coal-formation of Pictou, trunks of Conifers and *Calamites* are the most abundant fossils.

b. *Division 2*.—This occurs at Ragged Reef and its vicinity. Its thickness is 650 feet. It constitutes the lower part of the Upper Coal-formation.

The rocks are white and grey sandstones with occasional reddish beds, and red and grey shales. The sandstones and shales are nearly in equal proportions. Underclays, or soils supporting erect plants, probably *Sigillaria*, occur at two levels.

Fossils are not numerous. Those collected were *Sigillaria scutellata* and *Stigmaria ficoides*, *Calamites Suckovii*, *Sphenopteris hymenophylloides*, *Alethopteris lonchitica*, *Cyclopteris heterophylla* (?), *Beineria Goeperti*, and portions of the strobiles of two species of *Lepidophloios*, namely *Lepidophyllum lanceolatum* and *L. trinerve*.

c. *Division 3*.—This extends in descending order from the vicinity of Ragged Reef to McCairn's Brook. Its thickness is 2134 feet. It includes the upper part of the "Middle Coal-formation," and is perhaps equivalent, in part at least, to the Upper Coal-measures of Great Britain, and to the Upper Coal-formation of American authors.

It includes 1009 feet of sandstone, almost all of which is grey, and 912 feet of grey and reddish shale and clay. It contains 22 beds of coal, all of small thickness, and most of them of coarse quality. Below I give each bed of coal in detail, with its roof and floor and its fossils; and the intervening mechanical beds in brackets. The thickness of the roofs and floors is included in that stated for the intervening beds.

	ft.	in.
(Carbonaceous shale, grey understone, with <i>Stigmaria</i> and grey shale)	7	0
Coal-group 1 ... { Grey argillaceous shale.		
{ Coal 1 inch.....	0	1
{ Grey argillaceous underclay, <i>Stigmaria</i> .		
The roof holds abundance of <i>Alethopteris lonchitica</i> . The coal is coarse and earthy, with much epidermal and bast tissue*, vascular bundles of ferns, and impressions of <i>Sigillaria</i> and <i>Cordaites</i> . It is a compressed vegetable soil or dirt-bed, resting on an argillaceous subsoil with rootlets of <i>Stigmaria</i> .		
(Grey and reddish sandstones and grey and red shales with ironstone nodules).....	281	6
Coal-group 2 ... { Reddish argillaceous shale.		
{ Coal 1 inch.....		
{ Carbonaceous shale 4 inches...		
{ Coal 1 inch.....	0	6
{ Reddish underclay, <i>Stigmaria</i> .		

* For explanation as to the nature of these and other structures in the coal, see under § IV., below.

The coal is coarse, earthy, and shaly. It contains *Cordaites*, fern stipes, and bast tissue. ft. in.

	(Reddish shale and grey sandstone, the latter seen in the cliff to thin out and give place to reddish shale)	53	9
Coal-group 3 ...	{ Grey sandstone.	0	1
	{ Coal 1 inch.....		
	{ Grey and reddish sandy understone, <i>Stigmaria</i> .		

The coal is coarse and shaly. No fossils were observed, except stumps and rootlets of *Stigmaria* in the underclay.

	(Reddish grey shale and grey sandstone)	6	0
Coal-group 4 ...	{ Reddish grey shale.	0	2
	{ Coal 2 inches		
	{ Grey and reddish argillaceous underclay, <i>Stigmaria</i> .		

The coal is coarse and earthy. No fossils were observed, except *Stigmaria* rootlets in the underclay. This and the last coal are to be regarded merely as fossil vegetable soils or dirt-beds.

	(Grey sandstone and grey and reddish shale. One underclay, and erect <i>Calamites</i> in the lowest bed)	239	6
Coal-group 5 ...	{ Grey argillaceous shale.	0	2
	{ Coal 2 inches		
	{ Grey argillo-arenaceous underclay, <i>Stigmaria</i> .		

The coal is filled with leaves of *Cordaites borassifolia*, dividing it into thin papery layers. The underclay has many large branching roots of *Stigmaria*.

	(Grey shale and sandstone)	19	0
Coal-group 6 ...	{ Grey arenaceous shale.	0	3
	{ Coal 3 inches		
	{ Grey argillo-arenaceous underclay, <i>Stigmaria</i> .		

This coal is composed of flattened bark of *Sigillaria*, of which there are many layers in the thickness of the bed. The species are not distinguishable.

	(Grey sandstone and shale. One underclay with <i>Stigmaria</i>).....	12	6
Coal-group 7 ...	{ Grey argillaceous shale.	2	2
	{ Coal 1 inch.		
	{ Grey argillaceous underclay, <i>Stigmaria</i> , 1 ft. 6 in.		
	{ Coal 2 inches.		
	{ Grey argillaceous underclay, <i>Stigmaria</i> , 4 inches.		
	{ Coal 1 inch.		
	{ Grey argillaceous underclay, <i>Stigmaria</i>		

This is an alternation of thin coarse coals or fossil vegetable soils with *Stigmaria* subsoils. The roof-shale contains erect *Calamites*, which seem to have been the last vegetation which grew on the surface of the upper coal.

	(Grey and reddish sandstones and shales)	73	0
Coal-group 8 ...	{ Red and grey shale.	0	1
	{ Coal 1 inch.....		
	{ Grey hard underclay, <i>Stigmaria</i> .		

This coal contains flattened trunks of *Sigillaria scutellata*, or an allied species, and of other *Sigillaria*, also

abundance of vascular bundles of ferns and portions of ft. in. epidermal tissues of different plants.

(Grey sandstone and red and grey shales. <i>Stigmaria</i> in the upper bed, and prostrate <i>Sigillaria</i> and <i>Cordaites</i> in some of the sandstones and shales)...		490	0
Coal-group 9 ...	{ Grey argillaceous shale, ironstone nodules.		
	{ Coal 3 inches	0	3
	{ Argillo-arenaceous underclay, <i>Stigmaria</i> .		

The roof of this coal holds prostrate *Sigillariae* of three species and *Cordaites borassifolia*. The coal is hard and shining, with impressions of flattened *Sigillariae*, also of *Cordaites*, *Asterophyllites*, *Carpolites*, and vascular bundles of ferns.

(Underclay and reddish grey shale)		6	0
Coal-group 10...	{ Reddish grey shale.		
	{ Coal and coaly shale 8 inches.		
	{ Grey argillaceous underclay, nodules of ironstone, and <i>Stigmaria</i> 2 feet.		
	{ Coal, stony and compact, 2 inches	2	10
	{ Grey argillaceous underclay, <i>Stigmaria</i> .		

The roof-shale has obscure impressions of plants, apparently petioles of ferns. The upper coal is thinly laminated and full of leaves of *Cordaites* and ferns, among which is *Alethopteris lonchitica*. The lower coal is compact, resembling cannel, and has many vascular bundles of ferns. It seems to be composed of herbaceous matter macerated in water and mixed with mud.

(Grey sandstone and shale with nodules of ironstone)		23	0
Coal-group 11...	{ Grey argillaceous shale.		
	{ Coal, shaly, 3 inches	0	3
	{ Arenaceous underclay, <i>Stigmaria</i> .		

An erect ribbed *Sigillaria* appears in the roof-shale. The coal contains many flattened *Sigillariae*, also *Trigonocarpa*, *Cordaites*, and vascular bundles of ferns.

(Arenaceous understone with ironstone nodules and <i>Stigmaria</i> , and carbonaceous shale).....		7	9
Coal-group 12...	{ Carbonaceous shale.		
	{ Coal 2 inches	0	2
	{ Argillaceous underclay, ironstone, and <i>Stigmaria</i> .		

This coal is hard and laminated, with many vascular bundles of ferns upon its surfaces.

(Grey sandstone and grey argillaceous shale).....		12	0
Coal-group 13...	{ Grey argillaceous shale.		
	{ Coal 7 inches	0	7
	{ Grey argillaceous underclay, ironstone, and <i>Stigmaria</i> .		

The roof contains erect stumps, not distinctly marked. The coal has indications of bark of *Sigillaria*, and is hard and shining, with a coarse earthy layer in the middle.

(Grey shale)		7	0
Coal-group 14...	{ Grey shale, as above.		
	{ Coal 4 inches	0	4

Coal-group 14...	{ Grey argillo-arenaceous underclay, ironstone, and <i>Stigmara</i>	ft. in.
	Coal 2 inches	1 6
	Grey argillaceous underclay, ironstone, and <i>Stigmara</i> .	0 2

The upper coal has impressions of bark of trees and *Cordaite*s, especially in its upper part.

	(Grey and reddish shale and grey sandstone, with Stigmaraian soils at two levels)	52 0
	{ Grey shale.	
	Carbonaceous shale 2 inches.	
Coal-group 15...	{ Argillaceous underclay, ironstone, and <i>Stigmara</i> ...	1 0
	Coal 1 inch.....	0 3
	Argillaceous underclay, ironstone, and <i>Stigmara</i>	

The upper shaly bed is a coal interlaminated with shale, which enables the nature of the coaly matter to be ascertained. It contains flattened *Sigillaria*e of several species, *Calamites*, *Cordaite*s, *Cyperites*, leaves of *Sigillaria*, and *Lepidophylla*. The clay parting is the roof of the lower coal, and contains *Cyperites* and *Cordaite*s. It has been converted into an underclay by the growth of *Sigillaria* upon it in the formation of the upper bed of coaly shale. The lower coal is compact, but showed an impression of a *Calamite*.

	(Grey sandstone and grey and reddish shale, ironstone nodules).....	16 0
	{ Grey argillaceous shale.	
	Coal and carbonaceous shale 2 inches.....	0 2
Coal-group 16...	{ Reddish argillaceous underclay, ironstone, and <i>Stigmara</i> .	

The roof supports an erect tree, a *Sigillaria* 8 feet high and 1 foot in diameter. It is also rich in *Cyperites**, *Cordaite*s, and *Calamites*. The coal contains *Calamites* and and also discigerous tissue of Conifers or *Sigillaria*.

	(Grey sandstones and reddish and grey shales, with several Stigmaraian underclays and coaly films or thin vegetable soils. One of the underclays supports large stumps of <i>Sigillaria</i> , with <i>Cyperites</i> , <i>Cordaite</i> s, and <i>Lepidodendron</i> in the bed around their bases).....	38 6
	{ Red and grey argillaceous shale.	
	Coal 1 inch.	
	Gray argillo-arenaceous underclay, <i>Stigmara</i> , 4 ft.	
Coal-group 17...	{ Coal 4 inches.	
	Carbonaceous shale 4 inches.	
	Coal 1 inch.....	4 10
	Grey arenaceous underclay, <i>Stigmara</i> .	

The upper layer of coal consists in part of leaves of *Cordaite*s. The middle layer has much *Cordaite*s and *Cyperites*.

	(Underclay and grey shale).....	2 3
	{ Grey shale, as above.	
Coal-group 18...	{ Coal 3 inches	0 3
	Grey arenaceous underclay, <i>Stigmara</i> .	

* By this term I continue, for convenience, to designate the leaves of *Sigillaria*.

	(Grey sandstone, and red and grey shale. Stigmarian soils at two levels).....	ft. in. 26 0
Coal-group 19...	{ Reddish shale.	
	{ Coal 1 inch.....	0 1
	{ Red argillaceous underclay, <i>Stigmaria</i> .	

The roof contains an erect *Sigillaria*. The coal and that of the previous bed were not well seen.

	(Grey sandstone and red and grey shales, with many drift-trunks and erect <i>Sigillariæ</i> at four levels)...	222 0
Coal-group 20...	{ Grey shale.	
	{ Coal 1 inch.....	0 1
	{ Red and grey underclay, <i>Stigmaria</i>	36 0

This coal contains much *Cordaites*.

	(Grey and red shales and grey sandstone. One Stigmarian soil, and resting on it carbonaceous shale with <i>Cyperites</i>)	16 3
Coal-group 20a*	{ Grey shale.	
	{ Coal 2 inches.	
	{ Underclay, <i>Stigmaria</i> , 2 inches.	
	{ Coal 1 inch.	
	{ Underclay 1 inch, <i>Stigmaria</i> .	
	{ Coal 3 inches	0 9
	{ Argillaceous underclay, ironstone, and <i>Stigmaria</i> .	

These coals contain mineral charcoal, showing scalariform and epidermal tissues. The coals are impure, and were probably concealed at the time of Sir W. E. Logan's visit.

	(Sandstone and red and grey shale, with one Stigmarian soil).....	93 3
Coal-group 21...	{ Red shale.	
	{ Coal and carbonaceous shale, 2 inches.....	0 2
	{ Grey argillaceous underclay, <i>Stigmaria</i> .	

In the bed above the roof-shale are erect *Calamites*. The coal is an uneven or irregular bed, and consists of flattened *Sigillariæ*, *Cyperites*, *Cordaites*, and ferns.

	(Grey and reddish sandstones and shales, with drift-trunks of <i>Dadoxylon materiarium</i> , <i>Sigillaria</i> , and <i>Calamites</i>)	334 0
Coal-group 22...	{ Grey and red shale, nodules of ironstone.	
	{ Coal and carbonaceous shale, 2 inches	0 2
	{ Grey argillo-arenaceous underclay, <i>Stigmaria</i> .	

This coal consists of flattened bark of *Sigillaria* with *Cordaites*, and vascular bundles of ferns. It contains also remains of fishes. Among these was found a tooth of *Otenoptychius*. The underclay includes stumps of *Stigmaria*, as well as rootlets.

	(Grey sandstone and shale with one Stigmarian soil supporting erect stumps of <i>Sigillaria</i>).....	68 0
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Total thickness of Division 3, according to Logan's measurements..... 2159 8

d. *Division 4*.—This division of the section extends from Mc'Cairn's Cove to the end of the high cliff beyond "Coal-mine Point." It

* I designate in this way coal-groups not noticed in Logan's section.

corresponds to the lower part of the Middle Coal-formation, and probably to the Lower Coal-formation of some American authors. Its thickness, according to the measurements of Sir William E. Logan, is 2539 feet. It is remarkable for the prevalence of grey sandstones and grey and dark-coloured shales. It constitutes the part of the section re-examined by Sir C. Lyell and myself in 1852; and in the memoir which I subsequently published it is divided into 27 groups or subdivisions. For facility of reference these groups are indicated by the Roman numerals in the following pages, beginning with the highest group, XXVII.

XXVII.

Coal-group 1 ...	Bituminous limestone and calcareo-bituminous shale	ft. in.
	4 feet.	
	Coal 1 foot :	5 0
	Grey argillo-arenaceous underclay, <i>Stigmara</i> .	

The roof has *Naiadites carbonarius* and *N. elongatus*, *Spirorbis carbonarius*, scales of *Rhizodus*, and obscure vegetable fragments. The coal contains flattened *Sigillaria*, *Cordaites*, *Alethopteris lonchitica*, *Cyperites*, *Calamites Nova-scotica*, and many vascular bundles of ferns.

Coal-group 2 ...	(Grey sandstone and shale with six underclays and erect <i>Sigillaria</i> at two levels; also a thin shale with <i>Naiadites</i> , <i>Cythere</i> , <i>Calamites</i> , and <i>Cordaites</i> . One of the sandstones has scales and teeth of a large fish (? <i>Rhizodus</i>) and plants covered with <i>Spirorbis</i>)	50 0
	Grey argillaceous shale.	
	Coal 1 inch.	
	Clay 3 inches.	
	Coal 1 inch.	
	Clay 1 inch.	
	Coal 1 inch.	
	Shale 4 inches.	
	Coal 3 inches	1 2
	Grey argillo-arenaceous underclay, <i>Stigmara</i> .	

The roof has numerous vegetable fragments and flattened *Sigillaria* and *Calamites*. One of the coals contains mineral charcoal, showing bast tissue, scalariform tissue, and fragments of epidermis. The lower coal has bark of *Sigillaria*, *Stigmara*, and *Cyperites*, also numerous *Trigonocarpa* and vascular bundles of ferns. The clay partings and the underclay have obscure rootlets, probably of *Stigmara*.

Coal-group 3 ...	(Arenaceous underclay and shale with remains of <i>Stigmara</i> .)	
	Grey argillaceous shale.	
	Coal 3 inches	0 3
	Hard argillo-arenaceous underclay, <i>Stigmara</i> .	

The roof has stumps of *Sigillaria*, erect and with roots of *Stigmara* descending among them from the bed above. The coal, which is coarse and earthy, has vascular bundles of ferns, scalariform vessels, bast tissue, and scales and

spines of fishes (*Palæoniscus*, &c.), with coprolitic matter. ft. in.
The underclay shows abundant Stigmarian rootlets.

	(Underclay and grey arenaceous shale).....	6 0
	Grey argillaceous shale.	
	Coal 9 inches.	
	Carbonaceous shale 6 inches.	
	Coal 1 inch.	
	Carbonaceous shale 4 inches.	
Coal-group 4 ...	Coal 1 inch.	
	Carbonaceous shale 8 inches.	
	Coal 2 inches.	
	Grey shale 1 foot 7 inches.	
	Coal 8 inches	4 10
	Argillo-arenaceous underclay, <i>Stigmaria</i> .	

The roof contains obscure flattened plants. The coal is hard or shaly, with vascular bundles of ferns and bast tissue. The carbonaceous shales yield *Cordaite borassifolia*, *Althopteris lonchitica*, *Calamites*, *Sigillaria*, and *Cyperites*. The grey shale parting has erect stumps, apparently of *Sigillaria*. The upper shales and coals are very pyritous, and decompose when exposed to the weather—an indication that sea-water had access to these beds while the vegetable matter was still recent.

XXVI.

(Grey argillaceous sandstone and red and grey shale, with two Stigmarian soils. Footprints, probably of *Dendroperpeton*, and rain-marks occur in these beds; and it was in one of them that Mr. Marsh discovered the vertebræ of *Eosaurus Acadianus*). 82 0

XXV.

	Bituminous limestone 2 feet.	
	Coal $\frac{1}{2}$ inch.	
	Argillo-arenaceous clay, <i>Stigmaria</i> , 6 inches.	
	Coaly shale $\frac{1}{2}$ inch.	
Coal-group 5 ...	Grey argillo-arenaceous shale, ironstone nodules, <i>Stigmaria</i> , 1 foot 6 inches.	
	Coaly shale 1 inch.	
	Grey shale, ironstone nodules, <i>Stigmaria</i> , 2 ft. 6 in.	
	Coal 6 inches	7 2
	Argillo-arenaceous underclay, <i>Stigmaria</i> .	

The bituminous limestone of the roof contains *Naiadites carbonarius* and *N. elongatus*, fish-scales, and Cyprids. The upper layer of coal contains impressions of *Sigillaria* and *Lepidodendron*, on some of which are shells of *Spirorbis*. It has epidermal tissues, vascular bundles of ferns, and reticulated vessels. The coaly shales are of the nature of coarse coals, but with numerous thin layers of shaly matter. The lower coal contains petioles of ferns and *Cordaite* matted together, and numerous *Cardiocarpa*. The two thick clay partings and the underclay are Stigmarian soils.

XXIV.

(Grey sandstone and chocolate and grey shales, with two Stigmarian soils) 147 0

XXIII.

Coal-group 6 ...	{ Carbonaceous shale, passing downward into bituminous limestone, 1 foot 10 inches.	ft. in.
	{ Coal 4 inches	2 2
	{ Argillo-arenaceous underclay, <i>Stigmara</i> .	

The roof contains *Naiadites carbonarius*, *Cythere*, *Spirorbis*, fish-scales, and coprolites. The coal is hard and laminated, and has on its surfaces leaves of *Cordaites* and vascular bundles of ferns. It is remarkable for containing scattered remains of a number of species of fishes, belonging to the genera *Ctenoptychius*, *Diplodus*, *Palæoniscus*, and *Rhizodus*. The underclay has rootlets of *Stigmara*, and the bed below this has large roots of the same.

Coal-group 7 ...	(Grey sandstone and shale, the latter with nodules of ironstone. Erect trees at one level)	30 0
	{ Grey sandstone.	
	{ Coal 10 inches.	
	{ Carbonaceous shale 2 inches	
	{ Coal 10 inches.	
	{ Carbonaceous shale 2 inches.	
	{ Coal and coaly shale 2 feet 6 inches.....	4 6
	{ Grey argillo-arenaceous underclay, <i>Stigmara</i> .	

This is the bed worked at the Joggins as the "Main Seam;" and I believe that it improves somewhat in mining it inward from the shore. The roof has afforded *Sigillaria catenoides* and other species, *Alethopteris lonchitica*, *Cordaites borassifolia*, *Lepidodendron elegans*, *Trigonocarpa*, *Naiadites*, *Spirorbis*, *Cythere*, fragments of insects (?). The mineral charcoal contains bast tissue, scalariform, epidermal, and cellular tissues. In the compact part of the coal there is dense cellular and epidermal tissue. The roof is especially rich in *Cordaites*, sometimes with *Spirorbis* adherent.

Coal-group 8 ...	(Grey sandstone and shale, with many ironstone nodules in the shale, and erect <i>Sigillaria</i> and underclays at five levels. One of the latter has large stumps of <i>Stigmara</i> and a thin coaly layer resting on it)	68 0
	{ Grey shale with nodules of ironstone.	
	{ Coal 2 inches.	
	{ Grey shale 4 inches.	
	{ Coal 3 inches.	
	{ Carbonaceous shale 1 foot 3 inches.	
	{ Coal 1 inch.	
	{ Argillaceous shale, ironstone nodules, 4 feet.	
	{ Coal 1 foot.....	7 1
	{ Grey argillo-arenaceous underclay, ironstone nodules, and <i>Stigmara</i> .	

The roofs of the first and second beds in this group are among the richest in fossils in the Joggins section. They have afforded *Pecopteris lonchitica*, *Cyclopteris*, *Cyperites*, *Cordaites borassifolia*, *Cardiocarpum fluitans*, *Sigillaria elegans*, *Lepidophloios Acadianus*, *Lepidodendron undulatum*,

Pinnularia, *Trigonocarpa*, &c.; also *Diplostylus Dawsoni**, ft. in. *Eurypterus*, *Cythere*, *Naiadites*, and *Spirorbis* attached to plants. The lower coal, called locally the "Queen's Vein," has in its mineral charcoal bast cells, uniporous, rari-porous, and multiporous wood-cells, scalariform vessels, epidermal tissue, and vascular bundles of ferns, also stipes of ferns and bark of *Sigillaria*. The mineral charcoal occurs principally in a thick layer near the bottom of the bed. Its roof has trunks of *Lepidophloios*, *Lepidodendron*, and *Sigillaria*, fossilized by carbonate of iron. The upper part of the lowest underclay is dark and carbonaceous, with *Stigmariamian* rootlets.

XXII.

(Grey sandstones, grey and chocolate shales with ironstone nodules; three underclays and erect *Calamites* and *Sigillaria* in three beds) 110 0

XXI.

Coal-group 9 ... { Grey shale and ironstone nodules. 1 3
 { Coal and coaly shale 1 foot 3 inches
 { Argillaceous underclay, *Stigmaria*.

The roof contains erect *Sigillariae*, *Stigmariamia*, *Calamites*, and *Cordaite*s. The coaly shale has fern-stipes and *Cordaite*s. The coal itself is coarse and shaly, and has a layer of mineral charcoal containing bast and epidermal tissue. There are also in the coal remains of *Calamites* and *Cordaite*s, and fragments, possibly, of insects.

(Grey and reddish shales with nodules of clay-ironstone, and grey and reddish sandstone. One underclay supporting a coaly film, and erect trees at two levels) 28 6

Coal-group 10... { Chocolate shale.
 { Coal and coaly shale 2 inches.
 { Coaly shale 6 inches.
 { Coal 4 inches 1 0
 { Argillo-arenaceous underclay, *Stigmariamia*.

The upper coal contains flattened *Sigillariae* and *Stigmariamia*. The lower bed is hard and unequal, with curved laminae and obscure traces of petioles of ferns. The mineral charcoal has bast and scalariform tissues.

XX.

(Red and grey shales and grey sandstones. Erect *Calamites* in one bed. Four underclays) 78 6

XIX.

Coal-group 11... { Chocolate shale.
 { Coal and coaly shale 8 inches 0 8
 { Argillaceous underclay, *Stigmariamia*.

The roof has *Cordaite*s, *Calamites*, and rootlets. The coal contains much mineral charcoal with the structure of dense

* Salter, Quart. Journ. Geol. Soc. vol. xix. p. 77.

aporous bast tissue; it also contains *Cyperites* and many vascular bundles of ferns. ft. in.

	(Grey sandstones and argillaceous shale. Erect trees at two levels)	37 0
Coal-group 12...	{ Grey shale.	
	{ Coal and coaly shale 1 foot	1 0
	{ Argillaceous underclay, ironstone, and <i>Stigmara</i> .	

The roof contains erect *Sigillaria* and *Calamites*, also *Cordaites* with *Spirorbis* attached, and *Lepidodendron*. The coal has in one layer much *Cordaites*, in others it includes an immense number of specimens of *Sporangites papillata*; it has also bast tissue, epidermal tissue, and discigerous tissue.

	(Shale and sandstone, penetrated by Stigmarian rootlets, and containing in one of the shales <i>Lepidodendron</i> , <i>Sigillaria</i> , and <i>Carpolithes</i>)	13 0
Coal-group 13...	{ Grey shale.	
	{ Coal and coaly shale	0 6
	{ Argillaceous underclay, <i>Stigmara</i> .	

The roof has much *Cordaites*. The shaly portions of the coal contain *Sigillaria elegans*, *Alethopteris lonchitica*, *Cordaites borassifolia*, *Lepidodendron*, *Diplotegium*, *Trigonocarpum*, *Stigmara*, and *Sporangites glabra*, also vascular bundles of ferns and bast tissue.

XVIII.

	(Grey and red shales and grey sandstone; one of the latter with erect <i>Calamites</i> and <i>Sigillaria</i> . One underclay)	69 4
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XVII.

Coal-group 13a.	{ Grey shale.	
	{ Coal 8 inches	0 8
	{ Argillaceous underclay, <i>Stigmara</i> .	

The roof has *Cordaites* and many decayed stipes. The coal has *Cordaites* and vegetable fragments.

XVI.

	(A very thick sandstone with shales. Erect <i>Calamites</i> , footprints of reptiles, and rain-marks).....	57 0
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XV.

Coal-group 14...	{ Grey shales with ironstone.	
	{ Coal 3 inches.	
	{ Coaly shale 2 inches.	
	{ Coal 3 inches.	
	{ Underclay, <i>Stigmara</i> , 6 feet.	
	{ Coaly shale 4 inches.	
	{ Underclay, <i>Stigmara</i> , 1 foot.	
	{ Coaly shale 8 inches.	
	{ Coal 2 inches	8 10
	{ Argillo-arenaceous underclay, <i>Stigmara</i> , and ironstone.	

On the roof of the upper coal is a fine-ribbed *Sigillaria* with Stigmarian roots. In the roof and shaly partings

are *Sigillaria Brownii*, *S. Schlotheimiana*, and other species, ft. in,
Stigmara, *Lepidodendron*, *Calamites*, *Cordaite*s, *Sporangites*
glabra, *Alethopteris lonchitica*, *Sphenopteris latifolia*, *Pinnu-*
laria, and *Cyperites*; also *Cythere*, *Naiadites*, and fragments
of reptilian (?) bones. The coal is pyritous, and exhibits im-
pressions of the bark of *Sigillaria*; it contains also bast
tissue, scalariform tissue of *Sigillaria*, and multiporous tissue
of *Sigillaria* and *Calamodendron*.

	(Sandstone and shale, erect <i>Calamites</i> and <i>Sigillaria</i> with <i>Stigmara</i> . The erect trees contain repti- lian remains of the genera <i>Dendroperon</i> , <i>Hylo-</i> <i>nomus</i> , and <i>Hylperpeton</i> ; also <i>Pupa vetusta</i> , <i>Xy-</i> <i>lobius Sigillaria</i> , and remains of insects)	10 0
Coal-group 15...	{ Coaly shale. Coal 6 inches	0 6
	{ Arenaceous underclay, <i>Stigmara</i> .	

The erect trees above mentioned are rooted in the roof of
this coal. It contains *Cyperites*, *Lepidophylla*, *Trigonocarpa*
of 2 species, *Sphenophyllum*, *Alethopteris lonchitica*, *Cordaite*s,
and *Asterophyllites*. There are shells of *Spirorbis* on some
of the plants. The coal contains layers of bark of *Sigillaria*
and leaves of *Cordaite*s, and much bast tissue, with scalari-
form, uniporous, and reticulated tissues, probably of *Sigil-*
laria.

	(Sandstones and shales; erect <i>Calamites</i> and <i>Stig-</i> <i>mara</i>).....	21 0
Coal-group 15a.	{ Grey shale. Coal 4 inches	0 4
	{ Argillaceous underclay, <i>Stigmara</i> .	

The roof contains *Calamites*, *Sigillaria*, *Alethopteris lon-*
chitica, *Pinnularia*, *Lepidodendron*, *Cyperites*, *Sporangites*,
and *Spirorbis*. One *Sigillaria* extends 30 feet without
branching. The roof supports an erect tree. The coal is
filled with flattened stems of *Sigillaria* lying in different
directions, also flattened *Lepidodendra*; and in its mineral
charcoal it has beautiful porous and scalariform tissues.

XIV.

	(Grey sandstone and grey and red shales. Many prostrate trunks of <i>Sigillaria</i> and <i>Lepidodendron</i> , one underclay, and erect trees at one level)	68 0
Coal-group 16...	{ Shale with the aspect of underclay. Coal and coaly shale 6 inches	0 6
	{ Argillo-arenaceous underclay, ironstone, and <i>Stig-</i> <i>mara</i> .	

This bed was not well exposed, and afforded no fossils.

	(Grey sandstone and shale with one underclay)	25 6
Coal-group 17...	{ Grey shale. Coal and coaly shale 3 inches	0 3
	{ Argillo-arenaceous underclay, <i>Stigmara</i> .	

The roof has vegetable fragments and *Cordaite*s. The

coal is hard and coarse, and contains flattened broad-ribbed *Sigillaria*, *Cordaite*s, and vascular bundles of ferns. ft. in.

(Shale and sandstone, erect trees at one level) 31 3

XIII.

Coal-group 18... { Grey shale.
Coal 8 inches 0 8
Argillo-arenaceous underclay.

The roof has an erect *Sigillaria*. The coal is shaly and laminated. It contains much *Cordaite*s, also *Lepidodendron*, *Calamites*, and *Alethopteris lonchitica*. In one layer there are *Naiadites*, *Spirorbis*, and scales of fishes.

(Grey sandstone and shale in several beds, *Stigm*-
maria)..... 29 0

Coal-group 19... { Argillaceous shale.
Coaly shale 4 feet.
Bituminous limestone 2 feet 6 inches.
Coal 1 inch..... 6 7

The roof has *Naiadites*, scales and teeth of fishes, *Cythere*, and *Spirorbis*. The coal is hard and coarse, with vascular bundles of ferns and prostrate *Sigillaria*e.

(Shale and sandstone) 20 6

Coal-group 20... { Coaly shale 1 foot.
Bituminous limestone 1 foot 6 inches.
Coal and clay partings 2 feet 4 inches..... 4 10

The roof has *Naiadites*, *Spirorbis* attached to plants, and small rhombic fish-scales. The coal alternates with limestone at the top, and contains remains of *Sigillaria*, *Sporangites*, and vascular bundles of ferns.

(Sandstone, and grey and black shale with coaly
layers)..... 21 0

Coal-group 21... { Grey shale and calcareo-bituminous shale.
Coal 10 inches 0 10
Argillaceous underclay, *Stigm*aria.

The roof has obscure vegetable fragments and *Naiadites*. The coal contains vascular bundles of ferns, bast tissue, uniporous cells, and scalariform and reticulated vessels.

(Grey sandstone and shale. Two underclays)..... 20 0

Coal-group 22... { Grey shale.
Coal and coaly shale 2 inches 0 2
Argillaceous underclay, *Stigm*aria.

This bed was not well exposed.

(Sandstone and shale, with one erect tree and two
underclays)..... 12 0

Coal-group 23... { Coaly and grey shale.
Coal and coaly shale 4 inches.
Bituminous limestone 4 inches.
Coal and coaly shale 7 inches 1 3
Argillo-arenaceous underclay, *Stigm*aria.

The roof has an erect tree, also *Cordaite*s and *Spirorbis*. The shale and bituminous limestone contain *Sigillaria* and

Lepidophloios, also many large-furrowed trunks, probably ft. in. old *Sigillaria* or *Lepidodendra*.

XII.

	(Sandstone, shale, and calcareo-bituminous shale with three underclays)	26	0
Coal-group 24...	{ Calcareo-bituminous shale.	0	1
	{ Coal and coaly shale 1 inch		
	{ Argillo-arenaceous underclay, <i>Stigmaria</i> .		

This bed was not exposed.

	(Underclay and shale).....	5	0
Coal-group 25...	{ Grey shale.	0	8
	{ Coal and coaly shale 8 inches		
	{ Argillo-arenaceous underclay, <i>Stigmaria</i> .		

The roof has *Alethopteris lonchitica*, *Cordaites*, and petioles of ferns. The coal shows bast tissue and remains of *Sigillaria* and *Calamites*.

	(Grey sandstone and shale, with erect <i>Sigillaria</i> at four or five levels, and two Stigmarian underclays).....	117	8
Coal-group 26...	{ Grey shale.	0	4
	{ Coaly shale 4 inches		
	{ Argillo-arenaceous underclay, <i>Stigmaria</i> .		

This bed was not exposed.

	(Shale and sandstone, with <i>Stigmaria</i>).....	13	0
Coal-group 27...	{ Grey shale.	0	3
	{ Coal 3 inches		
	{ Argillo-arenaceous underclay, <i>Stigmaria</i> .		

This bed was not well exposed.

	(Grey sandstone and shale, with bituminous shale and limestone, and erect <i>Calamites</i>)	64	0
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XI.

	{ Calcareo-bituminous shale.	12	6
Coal-group 28...	{ Coal and coaly shale 7 feet.		
	{ Underclay, <i>Stigmaria</i> , 4 feet.		
	{ Coaly shale 1 foot.		
	{ Coal 6 inches		
	{ Arenaceous underclay, <i>Stigmaria</i> .		

This group is a series of thin coaly layers and underclays. The roof has *Naiadites carbonarius* and *N. elongatus*, also *Cythere* and scales of fishes. The coal contains bast tissue and different kinds of scalariform and epidermal tissues. In the lower bed is a coaly stump and an irregular layer of mineral charcoal, arising apparently from the decay of similar stumps.

	(Grey and carbonaceous shale and grey sandstone)...	29	0
Coal-group 29...	{ Underclay, <i>Stigmaria</i> .	21	0
	{ Coal and coaly shale 5 feet.		
	{ Underclay 6 feet.		
	{ Coal, coaly shale, and ironstone, 6 feet.		
	{ Coal 4 feet		
	{ Argillaceous underclay, <i>Stigmaria</i> .		

This is a group of unusually thick beds, indicating long quiescence. The roof includes laminae of coal, some of them composed of the bark of *Sigillaria catenoides*, also an erect *Sigillaria* rooted in the coal below. The coal and coaly shale exhibit remains of *Sigillaria*, *Cordaites*, *Lepidophyllum*, and *Oxyerites*; and one layer has many hard pyritized fragments of wood. The mineral charcoal has vascular bundles of ferns, coarse scalariform tissue, and porous tissue. The underclay rests on a bed with *Naiadites*.

	(Underclay, <i>Stigmara</i> , and grey and carbonaceous shales).....	18	0
Coal-group 29a {	Shale and coaly layers.		
	Coal 4 feet	4	0
	Argillaceous underclay, <i>Stigmara</i> .		

The roof has obscure fragments of plants and stumps in the state of mineral charcoal. The coal shows impressions of flattened trunks, probably *Sigillariae*. This coal contains a great variety of tissues, especially bast and scalariform of different kinds, and epidermal. My measurements in this part of the section differ somewhat from those of Sir W. E. Logan, who, I suppose, had not a good opportunity of examining the two last coals. The coal 29a is now mined by an adit from the shore, called the "new mine."

	(Sandstone and shale. One sandstone has many large erect <i>Sigillariae</i> , some of them with rough and furrowed bark)	35	0
Coal-group 30... {	Argillaceous shale and ironstone.		
	Coal 4 inches.		
	Underclay, dark-coloured, 2 feet.		
	Coal and coaly shale 2 inches.		
	Coal 3 inches.		
	Coaly shale 2 inches.		
	Coal 1 inch.....	3	0
	Soft argillaceous underclay, <i>Stigmara</i> .		

The roof has bark of *Sigillaria* preserved in ironstone. The coal is pyritous, and consists of layers of mineral charcoal alternating with bright coal; it has obscure impressions of plants and bast tissue in the mineral charcoal.

X.

	(Grey shale and sandstone. One underclay, and erect <i>Calamites</i> and <i>Sigillaria</i> at two levels)	19	0
Coal-group 31... {	Grey sandstone.		
	Coal and coaly shale 1 foot.		
	Underclay, <i>Stigmara</i> , 1 foot.		
	Coaly shale 6 inches.		
	Coal 2 inches	2	8
	Argillaceous underclay, <i>Stigmara</i> .		

The roof contains *Sigillariae*, and the coal has flattened impressions of the same. This coal is remarkable as having a roof of sandstone. Its underclay is also peculiar. It is about 9 feet in thickness, and contains *Stigmara* and nodules of

ironstone throughout. It rests on a bituminous limestone containing *Naiadites* and scales of fishes, and also large roots of *Stigmaria* evidently *in situ*. This bed gives more colour to the idea of *Stigmaria* having grown under water than any other bed at the Joggins. I believe, however, that it merely implies the drying-up of a pond or creek into a swamp, subsequently inundated at intervals with muddy water.

	(Underclay and bituminous limestone, succeeded by sandstone and shale)	27	8
	Grey shale.		
Coal-group 32...	{ Coal and coaly shale 2 feet 4 inches	2	4
	{ Argillo-arenaceous underclay, <i>Stigmaria</i> .		

This is a series of thin coaly bands alternating with shales. The roof contains trunks of *Sigillaria*, *Cordaites*, *Alethopteris*, and *Cyperites*. The coal has numerous flattened trunks of *Sigillaria*.

	(Grey and reddish sandstone and shale. Five underclays, one with a film of coal and erect <i>Sigillaria</i> at two levels)	149	0
	Coaly shale.		
Coal-group 33...	{ Coal 1 inch	0	1
	{ Argillaceous underclay, <i>Stigmaria</i> .		

The roof has flattened trunks and vegetable fragments. The coal is a mere soil, with remains of *Sigillaria* and *Cordaites*, and vascular bundles of ferns.

	(Red and grey sandstone and shale)	45	0
	Grey shale.		
Coal-group 33a.	{ Coal and coaly and grey shale (underclay).		
	{ Argillaceous underclay, <i>Stigmaria</i> .		

These layers, though not of sufficient importance to be measured as coal-bands, are most interesting as furnishing examples of what may be termed rudimentary coal-beds. Each layer is plainly composed of prostrate trunks of *Sigillaria* resting on Stigmarian underclay, and mixed with *Cordaites*, *Alethopteris lonchitica*, and vascular bundles of ferns. In one layer is a stump in the state of mineral charcoal. In another there are coprolites, scales of fishes, *Spirorbis*, and fragments of Crustaceans. In a reddish shale above these beds there is a patch of grey sandstone interlaced with Stigmarian roots, as if the sand had been prevented from drifting away by a tree or stump.

	(Reddish and grey sandstones and shales, with three or more underclays, having their coaly layers holding <i>Sigillaria</i> . Erect <i>Sigillaria</i> at two levels)	246	0
	Underclay, with ironstone and <i>Stigmaria</i> .		
	Coal and coaly shale 2 inches.		
Coal-group 34...	{ Underclay, with ironstone and <i>Stigmaria</i> , 4 feet.		
	{ Coal and coaly shale 2 inches	4	4
	{ Argillo-arenaceous underclay, <i>Stigmaria</i> .		

Only obscure vegetable fragments were observed.

	(Grey and reddish sandstone and shale, with <i>Stigmaria</i>)	13	10
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Coal-group 35...	Underclay with <i>Stigmara</i> .	ft. in.
	Coaly shale 3 inches	0 3
	Red and greenish underclay, a few rootlets.	

The coaly shale contains many leaves of *Cordaites borassifolia*.

(Red, grey, and dark shale, sandstone, and bituminous limestone. Three underclays and erect trees at one level)	67 9
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IX.

Coal-group 36...	Bituminous limestone.	
	Coaly shale and coal 3 inches.	
	Reddish shale and ironstone, 2 feet 6 inches.	
	Coal 3 inches	3 0
	Argillaceous underclay, <i>Stigmara</i> .	

The roof has *Stigmara* in situ, and has been a soil or underclay. It also contains *Cythere*, fish-scales, coprolites, and *Spirorbis*. In the upper coaly shale are prostrate carbonized trunks.

Coal-group 37...	(Reddish and grey shale, sandstone, and bituminous limestone)	21 6
	Bituminous limestone and shale.	
	Coal 4 inches.	
	Underclay 1 foot 6 inches.	
	Coal 6 inches.	
	Underclay 1 foot.	
	Bituminous limestone 3 inches.	
	Shale 3 inches.	
	Coal 1 inch	3 11
	Underclay with <i>Stigmara</i> .	

The roof has *Stigmara*, also fish-scales, *Naiadites*, and *Cythere*. The shales are pyritized. The coal shows only obscure fragments of plants; but *Sigillaria* in the state of ironstone occur in some of the clays.

VIII.

(Red and grey sandstone and shale. Two underclays. Many shells of <i>Pupa vetusta</i> occur in one of these, about 12 feet below the last coal)	83 0
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VII.

Coal-group 38...	Calcareo-bituminous shale.	
	Coal 1 inch.	
	Bituminous limestone 6 inches.	
	Coal 2 inches.	
	Underclay passing into chocolate shale, <i>Stigmara</i> .	

The bituminous limestone and shale contain *Cythere*, *Naiadites elongatus* and *N. carbonarius*, coprolites, *Spirorbis*, and *Stigmara*. The lower coal has *Sigillaria elegans*, *S. scutellata* (?), *S. Brownii*, *Alethopteris lonchitica*, *Cordaites borassifolia*, and vascular bundles of ferns.

(Red and grey shales and sandstones, and one grey limestone with <i>Cythere</i> . One underclay. Many drift trunks, among which are <i>Sigillaria</i> and <i>Lepidoph'oios</i>)	123 6
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V.

Coal-group 39...	Red and grey shale, with ironstone.	ft.	in.
	Coal $\frac{1}{2}$ inch	0	0 $\frac{1}{2}$
	Grey underclay, with <i>Stigmara</i> , resting on bituminous limestone, with <i>Stigmara</i> and <i>Cythere</i> .		

This thin coal consists of a layer of flattened trunks, probably of *Sigillaria*, with a quantity of mineral charcoal.

IV.

(Red and grey shales. One bed with erect <i>Calamites</i> , another with erect <i>Sigillaria</i>)	65	4
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III.

Coal-group 40...	Grey shale and ironstone.		
	Bituminous limestone and shale, with coaly films, 7 inches.		
	Underclay 1 foot.		
	Coal 1 inch.		
	Coaly shale 3 inches.		
	Underclay 1 foot.		
	Bituminous limestone 6 inches.		
	Coal and coaly shale 2 inches	3	7
	Argillaceous underclay, ironstone, and <i>Stigmara</i> .		

The bituminous limestone and shale have *Naiadites*, *Cythere*, *Spirorbis*, scales of fishes, and coprolites, and a large spine of *Gyracanthus*, also roots of *Stigmara*. The upper underclay holds carbonized erect trunks. The lower coal has vascular bundles of ferns and *Cordaites*. The roof supports erect stumps.

Coal-group 41...	(Underclay with ironstone nodules)	5	0
	Underclay as above.		
	Calcareo-bituminous shale and films of coal	3	4
	Argillaceous underclay, <i>Stigmara</i> .		

The bituminous limestone has *Naiadites carbonarius*, *Cythere*, coprolites, and *Spirorbis*. The roof has prostrate *Sigillaria* converted into coaly layers. The underclay has distinct stumps of *Stigmara*.

Coal-group 42...	(Shales with <i>Stigmara</i> and ironstone, sandstones, bituminous limestone, and carbonaceous shale at bottom)	14	4
	Bituminous limestone.		
	Coal 3 inches.		
	Shale 1 foot.		
	Coal 1 foot.		
	Underclay, <i>Stigmara</i> , 1 foot.		
	Coal 2 inches	3	5
	Dark argillaceous underclay, <i>Stigmara</i> .		

The roof contains *Naiadites*, *Cythere*, and coprolites. The coal is coarse, pyritous, and shaly, and has bark of *Sigillaria*, *Calamites*, and vascular bundles of ferns. It seems to be the edge of a bed, as it thins rapidly in the direction of the bank, or to the east.

	II.	ft. in.
	(Reddish shale and sandstone with one underclay	35 0
Coal-group 43...	Reddish underclay with <i>Stigmara</i> .	
	Coaly shale 1 inch	0 1
	Reddish underclay, <i>Stigmara</i> .	

This bed diminishes to a mere film towards the bank.

	I.	
	(Reddish, grey, and dark shales and sandstone, <i>Stigmara</i> in some beds, and erect <i>Sigillaria</i> and <i>Calamites</i> at one level)	63
Coal-group 44...	Grey shale with ironstone.	
	Bituminous limestone and shale with ironstone, 10 ft. 1 in.	
	Coal $\frac{1}{2}$ inch.	
	Bituminous limestone, <i>Stigmara</i> , $\frac{1}{2}$ inch.	
	Coal 5 inches.	
	Bituminous limestone, <i>Stigmara</i> , 2 inches.	
	Coal 1 inch.	
	Bituminous limestone, <i>Stigmara</i> , 2 inches.	
	Coal $\frac{1}{2}$ inch	11 0 $\frac{1}{2}$
	Argillo-arenaceous underclay, traces of rootlets.	

The bituminous limestone has scales of fishes, *Spirorbis*, and *Cythere*. The coal has *Cordaite*s and vascular bundles of ferns.

	(Red and grey sandstone and shale. One underclay, and erect <i>Calamites</i> at one level)	98 6
Coal-group 45...	Reddish shale.	
	Carbonaceous shale, 10 inches.	
	Coaly matter $\frac{1}{2}$ inch.	
	Hard underclay, <i>Stigmara</i> , 2 feet.	
	Coaly matter $\frac{1}{2}$ inch.	
	Underclay, <i>Stigmara</i> , 7 feet.	
	Coal 3 inches	10 2
	Arenaceous underclay, <i>Stigmara</i> .	

In the roof of the lower coal is an erect tree. The coal has vascular bundles of ferns, remains of fern-leaves, and bast tissue. The underclay has many coaly films, apparently flattened bark of trees.

	Reddish and grey sandstone and shale	5 6
Total thickness of Division 4, according to Logan's measurements.....		2539 1

c. *Division 5*.—This consists of reddish shales and red and grey sandstones. It contains no coal, and is poor in fossils, only a few drifted trunks appearing in the section. It corresponds to the upper part of the Millstone-grit series. Its thickness, according to the measurements of Sir William E. Logan, is 2082 feet.

f. *Division 6*.—This may be regarded as the middle of the Millstone-grit series. It constitutes a sort of false coal-formation, separated from the Middle Coal-formation by the barren beds of Division 5. It contains nine small or rudimentary coal-beds, which, however, are not well seen in the section, and have afforded few facts of interest. It has many thick and coarse sandstones and much red shale, with comparatively few dark-coloured beds. Its total thickness is stated by Sir W. E. Logan at 3240 feet.

Though this group contains little coal, it is to be observed that it has many underclays, indicating soils which supported forests of *Sigillaria*, and that erect *Sigillariae* occur very near the base of the division. The absence of important beds of coal is therefore due to the local physical conditions, and not to the want of the necessary vegetation.

	(Sandstones and shales with many drifted trunks of <i>Dadoxylon</i>)	ft.	in.
	<i>Dadoxylon</i>	539	7
Coal-group 1 ...	Blackish grey shale.		
	Calcareous shale 1 foot.		
	Black shale 3 feet.		
	Coaly shale 2 inches	4	2
	Argillo-arenaceous underclay, <i>Stigmara</i> .		
	(Red and grey sandstone and shale and concretionary limestone, trunks of <i>Dadoxylon</i> and other trees. One underclay)	160	1
Coal-group 2 ...	Grey shale.		
	Coaly shale 1 inch	0	1
	Reddish and grey underclay, <i>Stigmara</i> .		
	(Series of underclays with <i>Stigmara</i> . The beds are reddish or grey, and arenaceous)	19	1
Coal-group 3 ...	Reddish shale.		
	Coaly shale 1 inch.		
	Greenish shale 6 inches.		
	Coaly shale 1 inch.		
	Greenish shale 2 feet 6 inches.		
	Coaly shale 3 inches.		
	Greenish shale 1 inch.		
	Coal and coaly shale 3 inches	3	9
	Argillo-arenaceous underclay, <i>Stigmara</i> .		
	(Series of underclays as before).....	12	0
Coal-group 4 ...	Underclay, <i>Stigmara</i> .		
	Coal and coaly shale 3 inches	0	3
	Argillo-arenaceous underclay, <i>Stigmara</i> .		
	(Series of underclays as before)	24	0
Coal-group 5 ...	Grey shale.		
	Coaly matter $\frac{1}{2}$ inch	0	$\frac{1}{2}$
	Greenish underclay, <i>Stigmara</i> .		
	(Underclay and sandstone, the latter with an erect <i>Sigillaria</i>)	10	0
Coal-group 6 ...	Sandstone (erect <i>Sigillaria</i> as above),		
	Coaly shale 3 inches	0	3
	Argillo-arenaceous underclay, <i>Stigmara</i> .		
	(Fifteen feet of underclay, under which a thick sandstone with great quantities of drifted trunks of <i>Dadoxylon</i> and <i>Sigillaria</i> . Below this alternations of grey and red sandstone and shale)	210	10
Coal-group 7 ...	Grey sandstone.		
	Bituminous limestone 3 inches.		
	Grey shale 3 feet.		
	Grey limestone 2 inches.		
	Coaly shale 6 inches.		
	Bituminous limestone 3 inches.		
	Coaly shale 1 foot.		
	Coal 1 inch.....	5	3
	Argillo-arenaceous underclay, <i>Stigmara</i> .		

The lower bituminous limestone contains *Naiadites ovalis*, *Cythere*, and scales of Lepidoid fishes. The lower coal has much *Cyperites* and bark of *Sigillaria*, also bast tissue in mineral charcoal.

		(Thick beds of grey sandstone and grey shale, with drifted trunks of <i>Dadoxylon</i> , <i>Sigillaria</i> , and <i>Calamites</i> , and leaves of <i>Cordaite</i>)		532	0
Coal-group 8 ...	{	Grey shale.			
		Coal $\frac{1}{2}$ inch.....		0	$\frac{1}{2}$
		Argillo-arenaceous underclay, <i>Stigmara</i> .			

This coal is laminated, the laminæ being bark of *Sigillaria*. The underclay is very rich in *Stigmara*.

	(Grey sandstone with grey and red shale. Many drifted trunks of <i>Sigillaria</i> and <i>Calamites</i> , and an erect <i>Sigillaria</i> in the lowest bed of sandstone)...	1224	0
Coal-group 9 ...	{ Grey shale.		
	{ Coaly matter and carbonaceous shale	0	2
	{ Argillo-arenaceous underclay, <i>Stigmara</i> , and iron-stone.		
	(Grey and red sandstone and shale and calcareous bands, some of them bituminous. Near the middle a thick band of laminated black shale with <i>Naiadites levis</i> , <i>Cyperites</i> , and <i>Lepidostrobus</i> . Drifted <i>Calamites</i> in the sandstones)	496	4

Total thickness, according to Logan 3240 9

g. *Division 7*.—This division consists principally of red and chocolate shales with red and grey sandstone, arenaceous conglomerates, and thin beds of concretionary limestone. It may be regarded as the base of the Millstone-grit formation. Its thickness is stated by Sir W. E. Logan at 650 feet.

No fossils, other than carbonized fragments of plants, have been found in this division.

h. *Division 8*.—This division consists of reddish shales with greenish and red sandstone, grey shale, grey compact limestone, and gypsum. It may be regarded as the upper part of the Lower Carboniferous formation; and almost immediately under its lowest beds there are marine limestones with *Productus cora* and other characteristic Lower Carboniferous fossils.

Only fragments of plants, often replaced by sulphuret of copper, have been found in this division. Its thickness is stated by Logan at 1658 feet.

§ IV. REMARKS ON THE ANIMALS AND PLANTS WHOSE REMAINS OCCUR IN THE COAL.

1. *Introduction*.—Under this heading I shall, in the first place, present a tabular view of the relative frequency of occurrence of the several genera in the beds of coal and their roof-shales, without reckoning the almost invariable occurrence of *Stigmara* in the underclays, which is of course to be taken as an indication of the existence of Sigillarioid trees in connexion with the growth of the coal.

The number of coals reckoned may vary according to the manner in which the several layers are grouped; but as arranged in the above sectional list it amounts to eighty-one in all. Of these, 23 are found in Division 3 of Logan's section, being the upper member of the Middle Coal-formation; 49 are found in Division 4 of Logan's section, being the lower member of the Middle Coal-formation; 9 occur in Division 6 of Logan's section, or in the equivalent of the Millstone-grit. In the latter group few of the coals were sufficiently well exposed to enable a satisfactory examination to be made. I have grouped the remains under three heads—External Forms of Plants, Microscopic Structure of Plants, and Animal Remains—and have arranged the forms under each in the order of their relative frequency of occurrence.

Table showing the Relative Frequency of Occurrence of Genera of Plants and Animals in the Coals of the South Joggins.

Names of Fossils.	Division 3. 23 coals.	Division 4. 49 coals.	Division 6. 9 coals.	Total. 81 coals.
<i>Plants.</i>				
Sigillaria..... occurs in	13	34	2	49
Cordaites	15	26	...	41
Filices (mostly <i>Alethopteris lonchitica</i>) ..	4	17	2	23
Lepidodendron and Lepidophloios ...	1	15	...	16
Calamites	4	12	...	16
Carpolites, &c.	2	9	...	11
Asterophyllites	1	2	...	3
Calamodendron	...	1	...	1
<i>Structures.</i>				
Vascular bundles of ferns	8	22	...	30
Bast tissue (<i>Sigillaria</i>) ..	2	16	2	20
Epidermal tissue (<i>Cordaites</i> , &c.) ...	6	6	...	12
Scalariform (<i>Sigil.</i> , <i>Stig.</i> , <i>Lepidod.</i> , &c.) ..	1	9	1	11
Discigerous (<i>Sigillaria</i> and <i>Dadoxylon</i> , &c.) ..	1	8	1	10
Reticulated (<i>Calamodendron</i> , Ferns, &c.) ..	...	2	1	3
<i>Animals.</i>				
Fishes (<i>Palæoniscus</i> , <i>Rhizodus</i> , &c.) ...	1	16	1	18
Naiadites (<i>Anthracomya</i> , &c.) ..	...	16	1	17
<i>Spirorbis carbonarius</i> ..	...	16	...	16
<i>Cythere</i>	...	13	1	14
Insects (?)	...	3	...	3
Reptiles (<i>Dendropepon</i> , &c.) ..	...	1	...	1
<i>Pupa vetusta</i> and <i>Xylobius sigillariae</i>	...	1	...	1

It will be observed that, whether we regard the external forms or the internal structures preserved, the predominant plants are *Sigillaria*, *Cordaite*s, and Ferns, with *Lepidodendron* and *Calamites*. The substance of the coal itself, so far as its structure is preserved, may be said to be principally composed of bark of *Sigillaria* and leaves and stems of ferns and *Cordaite*s. In regard to the proportions in different parts of the series, little difference exists, except that *Cordaite*s and *Calamites* are rather more abundant in the upper coals, and *Lepidodendron* in the lower, while the middle of the series is the headquarters of *Sigillaria* and ferns. Remains of aquatic animals occur in connexion with a large proportion of the coals, more especially in the middle of the series. This may be explained in connexion with the theory of growth of the coal *in situ* by the following considerations:—(1) It was necessary to the preservation of the vegetable matter composing a bed of coal that it should be submerged and covered with sediment. (2) On the submergence of a swamp covered with standing trees and other vegetation, these would prevent the passage of strong currents carrying coarse detritus, and the area would be covered with fine sediment deposited in still water and under conditions favourable to certain kinds of aquatic animals. (3) When the currents carrying detritus were sufficiently powerful to uproot and sweep away the forests and the brakes of *Calamites*, they would also remove or disturb the vegetable soil. It follows that we should expect the more important coals to be covered with fine sediment containing animal as well as vegetable remains, and that beds roofed with sandstone or coarse shale must either have been of small area or sparsely covered with trees at the time of their submergence. This accounts for the otherwise anomalous circumstance that the evidences of aqueous conditions in association with the coal are proportionally more abundant in the middle than in the upper part of the Coal-measures. We may now proceed to consider the genera of plants and animals separately, in their relation to the growth of coal.

2. *Coniferous Trees*.—Four species of coniferous trees, referable to the genus *Dadoxylon*, have been found in the Coal-formation of Nova Scotia. They are known to me only by the microscopic structure of their wood; but on the evidence afforded by this I have named and described them as new species*. One of them, *D. antiquius*, is closely allied to *D. Withami* of Great Britain, and, like that species, belongs to the Lower Carboniferous Coal-measures. Its structure is of that character for which Brongniart proposed the generic name "*Palæoxylon*." It has not yet been found at the Joggins. Another species, *D. Acadianum*, is found abundantly at the Joggins in the condition of drifted trunks imbedded in the sandstone of the lower part of the Coal-formation and the upper part of the Millstone-grit series. The third species, *D. materiarium*, is very near to *D. Brandlingii* of Great Britain, and may possibly be only a variety. It is especially abundant in the sandstone of the Upper Coal-formation, in

* Descriptions referred to here and in subsequent pages will be found in "Synopsis of the Flora of the Carboniferous Period," Can. Nat. vol. viii., and in the Appendix.

which vast numbers of drifted trunks of this species occur in some places. The fourth species, *D. annulatum*, presents a very peculiar structure, probably of generic value. It has alternate concentric rings of discigerous woody tissue, of the character of that of *Dadoxylon*, and of compact structureless coal, which either represents layers of very dense wood or, more likely, of corky cellular tissue. In the latter case the structure would have affinities with that of certain *Gnetaceæ* and of Cycads.

Though coniferous trees usually occur as decorticated and prostrate trunks, I have recorded the occurrence of one erect specimen, in a sandstone a little above the "Main Coal," at the Joggins. It probably belonged to the species last named. Tissues of coniferous trees are very rare in the coal itself. Most of the discigerous tissues found in the coal belong to *Sigillaria* and *Calamodendron*. From the abundance of coniferous trees in sandstones above and below the coal, and their comparative absence in the coal and coal-shales, it may be inferred that these trees belonged rather to the uplands than to the coal-swamps; and the great durability and small specific gravity of coniferous wood would allow it to be drifted, either by rivers or ocean-currents, to very great distances. I am not aware that the fruits of pine trees occur at the Joggins, unless some of the *Trigonocarpa* are of this character. Nor has any foliage of these trees been found; but at Tatmagonche, in the continuation of the Upper Coal-formation, there are leafy branchlets which I have named *Araucarites gracilis*, and which may possibly have belonged to *Dadoxylon materiarium*.

The casts of pith-cylinders known as *Sternbergiæ* are abundant in some of the sandstones, especially in the Upper Coal-formation. I have shown that in Nova Scotia, as in England, some of these singular casts belong to *Dadoxylon**; but as the pith-cylinder of *Sigillaria* and of *Lepidophloios* was of a similar character, those which are destitute of woody investment cannot be determined with certainty, though in general the transverse markings are more distant in the *Sternbergiæ* of *Sigillaria* and *Lepidophloios* than in those of *Dadoxylon*.

In Plate V., and in Plate VI. fig. 14, I have given illustrations of the coniferous plants above referred to.

3. *Sigillariæ*.—I have catalogued or described no less than twenty-one species belonging to this family, from the Coal-measures of Nova Scotia. They may be arranged under the following provisional genera:—

- | | |
|--|--|
| (1.) FAVULARIA, <i>Sternberg</i> | <i>Sigillaria elegans</i> , <i>Brongn.</i> |
| | — <i>tessellata</i> , <i>Brongn.</i> |
| | — <i>Bretonensis</i> , <i>Dawson.</i> |
| (2.) RHYTIDOLEPIS, <i>Sternberg</i> . . | — <i>scutellata</i> , <i>Brongn.</i> |
| | — <i>Schlotheimiana</i> , <i>Brongn.</i> |
| | — <i>Saullii</i> , <i>Brongn.</i> |
| | — <i>Dournaisii</i> , <i>Brongn.</i> |
| | — <i>Knorrii</i> , <i>Brongn.</i> |

* Proceedings of the American Association, 1837, Canadian Naturalist, vol. ii. Paper on Structures of Coal, Quart. Journ. Geol. Soc. 1860.

- (2.) RHYTIDOLEPIS (*continued*) *Sigillaria pachyderma*, *Brongn.*
 — *flexuosa*, *L. & H.?*
 — *elongata*, *Brongn.*
 (3.) SIGILLARIA, *Brongn.* — *reniformis*, *Brongn.*
 — *Brownii*, *Dawson.*
 — *laevigata*, *Brongn.*
 — *planicosta*, *Dawson.*
 — *catenoides*, *Dawson.*
 — *striata*, *Dawson.*
 — *eminens*, *Dawson.*
 (4.) CLATHRARIA, *Brongn.* — *Menardi*, *Brongn.*
 (5.) LEIODERMA, *Goldenb.* — *Sydnensis*, *Dawson.*
 (*Asolanus*, *Wood*).
 (6.) SYRINGODENDRON, *Sternb.* — *organum*, *L. & H.*

Of these, seven are probably new species, and the remainder can be identified with reasonable certainty with European species. The differences in the markings in different parts of the same tree are, however, so great, that I regard the greater part of the recognized species of *Sigillaria* as merely provisional. Even the generic limits may be overpassed when species are determined from hand specimens. A fragment of the base of an old trunk of *Sigillaria* proper would necessarily be placed in the genus *Leioderma*, and a young branch of *Favularia* has all the characters of the genus *Clathraria*. It is, however, absolutely necessary to make some attempt at generic distinction among the diverse forms included in the genus *Sigillaria*; otherwise it will be impossible to reconcile the conflicting statements of authors as to the dimensions, habit of growth, foliage, roots, and fructification of these singular plants;—such statements usually applying to one or more of the subordinate generic types. I shall therefore notice separately, and with especial reference to their function in the production of coal, the several generic or subgeneric forms, beginning with that which I regard as the most important—namely, *Sigillaria* proper, of which, in Nova Scotia, I regard the species which I have named *S. Brownii* (figs. 15 to 20, Pl. VI.) as the type. Other species are represented in figs. 21 to 28.

In the restricted genus *Sigillaria* the ribs are strongly developed, except at the base of the stem; they are usually much broader than the oval or elliptical tripunctate areoles, and are striated longitudinally. The woody axis has both discigerous and scalariform tissues, arranged in wedges, with medullary rays as in exogens*; the pith is transversely partitioned in the manner of *Sternbergia*; and the inner bark contains great quantities of long and apparently very durable fibres, which I have, in my descriptions of the structures in the coal, named “bast tissue.” The outer bark was usually thick, of dense and almost indestructible cellular tissue. The trunk when old lost its regular ribs and scars, owing to expansion, and became furrowed like that of an old exogenous tree. The roots were *Stigmariæ* of the type of the ordinary *S. ficoides*. I have not seen the

* Quart. Journ. Geol. Soc., paper on Structures of Coal.

leaves or fruits attached; but, from the associations observed, I believe that the former were long, narrow, rigid, and two- or three-nerved (*Cyperites*), and that the latter were *Trigonocarpa*, borne in racemes on the upper part of the stem. These trees attained to a great size. I have seen one trunk four feet in diameter, and specimens of two feet or more in diameter are common: some of these trunks have been traced for thirty or forty feet without branching. The greater number of the erect stumps preserved at the Joggins appear to belong to this genus, which also seems to have contributed very largely to the formation of coal. Judging from the paucity of their foliage, the density of their tissues, and the strong structural resemblance of their stems and roots to those of Cycads, I believe that their rate of growth must have been very slow.

The genus *Rhytidolepis*, in which the areoles are large, hexagonal, and tripunctate, and the ribs narrow and often transversely striate, ranks as a coal-producer next to *Sigillaria* proper, and is equally abundant in the Coal-measures. These trees seem to have been of smaller size and feebler structure than the last mentioned, and are less frequently found in the erect position; but they are very abundant on the roofs of the coal-beds. Judging from such specimens as I have seen, their roots were less distinctly Stigmarioid than in the last genus, though this appearance may arise from difference of preservation. Their leaves were of the same type as in the last genus; and their stems bear rings of irregular scars, which may mark stages of growth, or the production of slender racemes of fruit in a verticillate manner. The woody axis of the stems of this genus was composed of scalariform and coarsely porous tissues, much like those of modern Cycads. I figure, as an illustration of the genus, a fragment of *S. scutellata* showing one of the belts of abnormal scars.

The genus *Favularia* is represented in Nova Scotia principally by the typical species *S. elegans* of Brongniart. The admirable investigations of the structure of the stem of this species by Brongniart, with the further illustrations given by Corda, Hooker, and Goldenberg, still afford the best general views of the structure of *Sigillariae* which we possess*. It is to be observed, however, that Brongniart's specimen was a young stem or a branch, and that it affords a very imperfect idea of the development of discigerous and bast tissues in the full-grown stems of *Sigillaria* proper. The trees of this genus appear to have been of small growth; and they branched in the manner of *Lepidodendron*, the smaller branches being quite destitute of ribs, and with the areoles elliptical and spirally disposed. The stems show joints or rings of peculiar scars at intervals, as in the last genus. The leaves differ from those of the other genera; being broad and with numerous slender parallel veins, almost in the manner of *Cordaitea*. (Figs. 26 and 27, Plate VII.)

The genus *Clathraria* is evidently closely allied to the above, and is possibly founded on branches of trees of the genus *Favularia*. It is a rare form in Nova Scotia.

* See also Binney "On some Fossil Plants showing Structure, from the Lower Coal-measures of Lancashire," Quart. Journ. Geol. Soc. vol. xviii. p. 106.—EDIT.

Of the genus *Leioderma* or *Asolanus* I know but one species, independently of those specimens of old trunks of the ordinary *Sigillaria* in which the ribs have disappeared. My species, *S. Sydneensis*, is founded on specimens collected by Mr. Brown at Sydney, Cape Breton, which are especially remarkable for the curious modification which they present of the Stigmarian root. The specimens described by Mr. Brown under the name of *S. alternans**, and which have been copied by Geinitz and Goldenberg, belong, I believe, to this species. (Fig. 28, Plate VII.)

On the genus *Syringodendron* of Sternberg I have no observations to make. I have seen only fragments of stems; and these seem to be very rare.

I include under *Stigmaria* the remarkable fossils known as *Stigmaria*, being fully convinced that all the varieties of these plants known to me are merely roots of *Sigillaria*; I have verified this fact in a great many instances, in addition to those so well described by Mr. Binney and Mr. Brown. The different varieties or species of *Stigmaria* are no doubt characteristic of different species of *Sigillaria*, though in very few cases has it proved possible to ascertain the varieties proper to the particular species of stem. The old view, that the *Stigmaria* were independent aquatic plants, still apparently maintained by Goldenberg and some other palæobotanists, evidently proceeds from imperfect information. Independently of their ascertained connexion with *Sigillaria*, the organs attached to the branches are not leaves, but rootlets. This was made evident long ago by the microscopic sections published by Goeppert, and I have ascertained that the structure is quite similar to that of the thick fleshy rootlets of *Cycas*. The lumps or tubercles on these roots have been mistaken for fructification; and the rounded tops of stumps, truncated by the falling in of the bark or the compression of the empty shell left by the decay of the wood, have been mistaken for the natural termination of the stem†. The only question remaining in regard to these organs is that of their precise morphological place. Their large pith and regular areoles render them unlike true roots; and hence Lesquereux has proposed to regard them as *rhizomes*. But they certainly radiate from a central stem, and are not known to produce any true buds or secondary stems. In short, while their function is that of roots, they may be regarded, in a morphological point of view, as a peculiar sort of underground branches. They all ramify very regularly in a dichotomous manner, and, as Mr. Brown has shown, in some species at least, give off conical tap-roots from their underside.

In all the *Stigmaria* exhibiting structure which I have examined, the axis exhibits only scalariform vessels. Corda, however, figures a species with wood-cells, or vessels with numerous pores, quite like those found in the stems of *Sigillaria* proper; and, as Hooker has pointed out, the arrangement of the tissues in *Stigmaria* is similar to that in

* Quart. Journ. Geol. Soc. vol. v. p. 354 *et seq.*

† For examples of the manner in which a natural termination may be simulated by the collapse of bark or by constriction owing to lateral pressure, see my papers, Quart. Journ. Geol. Soc. vol. x. p. 35, and vol. vii. p. 194.

Sigillaria. After making due allowance for differences of preservation, I have been able to recognize eleven species or forms of *Stigmarmaria* in Nova Scotia, corresponding, as I believe, to as many species of *Sigillaria**. At the Joggins, *Stigmarmaria* are more abundant than any other fossil plants. This arises from their preservation in the numerous fossil soils or *Stigmarmaria* underclays. Their bark, and mineral charcoal derived from their axes, also abound throughout the thickness of the coal-beds, indicating the continued growth of *Sigillaria* in the accumulation of the coal. (Figs. 83 to 87 Pl. XII.)

Our knowledge of the fructification of *Sigillaria* is as yet of a very uncertain character. I am aware that Goldenberg has assigned to these plants leafy strobiles containing spore-capsules: but I do not think the evidence which he adduces conclusive as to their connexion with *Sigillaria*; and the organs themselves are so precisely similar to the strobiles of *Lepidophloios*, that I suspect they must belong to that or some allied genus. The leaves, also, with which they are associated in one of Goldenberg's figures seem more like those of *Lepidophloios* than those of *Sigillaria*. If, however, these are really the organs of fructification of any species of *Sigillaria*, I think it will be found that we have included in this genus, as in the old genus *Calamites*, two distinct groups of plants, one cryptogamous, and the other phænogamous, or else that male strobiles bearing pollen have been mistaken for spore-bearing organs.

I cannot pretend that I have found the fruit of *Sigillaria* attached to the parent stem; but I think that a reasonable probability can be established that some at least of the fruits included, somewhat vaguely, by authors under the names of *Trigonocarpum* and *Rhabdocarpus* were really fruits of *Sigillaria*. These fruits are excessively abundant and of many species, and they occur not only in the sandstones but in the fine shales and coals and in the interior of erect trees, showing that they were produced in the coal-swamps. The structures of these fruits show that they are phænogamous and probably gymnospermous. Now the only plants known to us in the coal-formation, whose structures entitle them to this rank, are the *Conifers*, *Sigillariae*, and *Calamodendra*. All the others were in structure allied to cryptogams, and the fructification of most of them is known. But the *Conifers* were too infrequent in the Carboniferous swamps to have afforded numerous species of *Carpolites*; and, as I shall presently show, the *Calamodendra* were very closely allied to *Sigillariae*, if not members of that family. Unless, therefore, these fruits belonged to *Sigillaria*, they must have been produced by some other trees of the coal-swamps, which, though very abundant and of numerous species, are as yet quite unknown to us. Some of the *Trigonocarpa* have been claimed for *Conifers*, and their resemblance to the fruits of *Salisburya* gives countenance to this claim; but the *Conifers* of the Coal-period are much too few to afford more than a fraction of the species. One species of *Rhabdocarpus* has been attributed by Geinitz to the genus *Næggerathia*; but the leaves which he assigns to it are very like those of *Sigillaria elegans*, and may belong to some allied species. With

* See Appendix.

regard to the mode of attachment of these fruits, I have shown that one species, *Trigonocarpum racemosum* of the Devonian strata*, was borne on a rachis in the manner of a loose spike, and I am convinced that some of the groups of inflorescence named *Antholithes* are simply young *Rhabdocarpi* or *Trigonocarpa* borne in a pinnate manner on a broad rachis and subtended by a few scales. Such spikes may be regarded as corresponding to a leaf with fruits borne on the edges, in the manner of the female flower of *Cycas*; and I believe with Goldenberg that these were borne in verticils at intervals on the stem. In this case it is possible that the strobiles described by that author may be male organs of fructification containing, not spores, but pollen. In conclusion, I would observe that I would not doubt the possibility that some of the fruits known as *Cardiocarpa* may have belonged to Sigillarioid trees. I am aware that some so-called *Cardiocarpa* are spore-cases of *Lepidodendron*; but there are others which are manifestly winged nutlets allied to *Trigonocarpum*, and which must have belonged to phænogams. It would perhaps be unwise to insist very strongly on deductions from what may be called circumstantial evidence, as to the nature of the fruit of *Sigillaria*; but the indications pointing to the conclusions above stated are so numerous that I have much confidence that they will be vindicated by complete specimens, should these be obtained. (Figs. 29 and 30, Pl. VII., and figs. 69 to 79, Pl. XII.)

All of the Joggins coals, except a few shaly beds, afford unequivocal evidence of *Stigmaria* in their underclays; and it was obviously the normal mode of growth of a coal-bed, that, a more or less damp soil being provided, a forest of *Sigillaria* should overspread this, and that the Stigmarian roots, the trunks of fallen *Sigillariæ*, their leaves and fruits, and the smaller plants which grew in their shade, should accumulate in a bed of vegetable matter to be subsequently converted into coal—the bark of *Sigillaria* and allied plants affording “bright coal,” the wood and bast tissues mineral charcoal, and the herbaceous matter and mould dull coal. The evidence of this afforded by microscopic structure I have endeavoured to illustrate in a former paper†.

The process did not commence, as some have supposed, by the growth of *Stigmaria* in ponds or lakes. It was indeed precisely the reverse of this, the *Sigillaria* growing in a soil more or less swamp, but not submerged, and the formation of coal being at last arrested by submergence. I infer this from the circumstance that remains of Cyprids, Fishes, and other aquatic animals are rarely found in the underclays and lower parts of the coal-beds, but very frequently in the roofs, while it is not unusual to find mineral charcoal more abundant in the lower layers of the coal. For the formation of a bed of coal, the sinking and subsequent burial of an area previously dry seems to have been required. There are a few cases at the Joggins where *Calamites* and even *Sigillariæ* seem to have grown on areas liable to frequent inundation; but in these cases coal did not accumulate. The non-laminated, slickensided and bleached condition of most of the underclays indicates soils of considerable permanence.

* “Flora of the Devonian Period,” Quart. Journ. Geol. Soc. vol. viii. p. 324.

† “On the Structures in Coal,” Quart. Journ. Geol. Soc. 1859.

In regard to beds destitute of Stigmarian underclays, the very few cases of this kind apply only to shaly coals filled with drifted leaves, or to accumulations of vegetable mud capable of conversion into impure coal. The origin of these beds is the same with that of the carbonaceous shales and bituminous limestones already referred to. It will be observed in the section that in a few cases such beds have become sufficiently dry to constitute underclays, and that conditions of this kind have sometimes alternated with those favourable to the formation of true coal.

There are some beds at the Joggins, holding erect trees *in situ*, which show that *Sigillariae* sometimes grew singly or in scattered clumps, either alone or amidst brakes of *Calamites*. In other instances they must have grown close together, and with a dense undergrowth of ferns and *Cordaites*, forming an almost impenetrable mass of vegetation.

From the structure of *Sigillariae* I infer that, like Cycads, they accumulated large quantities of starch, to be expended at intervals in more rapid growth, or in the production of abundant fructification. I adhere to the belief expressed in previous papers that Brongniart is correct in regarding the *Sigillariae* as botanically allied to the *Cycadaceae*, and I have recently more fully satisfied myself on this point by comparisons of their tissues with those of *Cycas revoluta*. It is probable, however, that when better known they will be found to have a wider range of structure and affinities than we now suppose.

There are some reasons for believing that the trees described by Corda under the names of *Diploxyylon*, *Myelopithys*, and *Heterangium*, and also the *Anabathra* of Witham, are *Sigillariae*. Much of the tissue described by Goeppert as *Araucarites carbonarius* is probably also *Sigillarian*.

4. *Calamodendron*.—The plants of this genus are quite distinct from *Calamites* proper. A *Calamodendron* as usually seen is a striated cast with frequent cross lines or joints; but when the whole stem is preserved, it is seen that this cast represents merely an internal pith-cylinder, surrounded by a woody cylinder composed in part of scalariform or reticulated vessels, and in part of wood-cells with one row of large pores on each side. External to the wood was a cellular bark, and the outer surface seems to have been simply ribbed in the manner of *Sigillaria*. It so happens that the internal cast of the pith of *Calamodendron*, which is really of the nature of a *Sternbergia*, so closely resembles the external appearance of the true *Calamites* as to be constantly mistaken for them. Most of these pith-cylinders of *Calamodendron* have been grouped in the species *Calamites approximatus*; but that species, as understood by some authors, appears also to include true *Calamites**, which, however, when well preserved, can always be distinguished by the scars of the leaves or branchlets which were attached to the nodes.

Calamodendron would seem, from its structure, to have been closely allied to *Sigillaria*, though, according to Unger, the tissues were dif-

* See Geinitz, "Steinkohlenformation in Sachsen."

ferently arranged, and the woody cylinder must have been much thicker in proportion.

The tissues of *Calamodendron* are by no means infrequent in the coal, and casts of the pith are common in the sandstones; but its foliage and fruit are unknown. (Fig. 31, Pl. VII., *a* to *c*.)

5. *Calamites*.—Nine species of true *Calamites* have been recognized in Nova Scotia, of which seven occur at the Joggins, the most abundant being *C. Suckovii* and *C. Cisti*. The *Calamites* grew in dense brakes on sandy and muddy flats. They were unquestionably allied to *Equisetaceæ*, and produced at their nodes either verticillate simple linear leaves, as in *C. Cisti*, or verticillate branchlets with pinnate or verticillate leaflets, as in *C. Suckovii* and *C. nodosus*. The *Calamites* do not seem to have contributed much to the growth of coal, though their remains are not infrequent in it. The soils in which they most frequently grew were apparently too wet and liable to inundation and silting up to be favourable to coal-accumulation. I have elsewhere shown that some of the species of *Calamites* gave off numerous adventitious roots from the lower parts of their stems, and also multiplied by budding at their bases*.

Of the genus *Equisetites* one species has been found in Cape Breton; but it has not as yet been recognized at the Joggins. (Fig. 88, Pl. XII.)

6. *Asterophyllites*, &c.—Five species of *Asterophyllites*, one of *Annularia*, five of *Sphenophyllum*, and three of *Pinnularia*, have been found in Nova Scotia. I place these together as probably allied plants. The *Pinnulariæ* were apparently slender roots, with thin epidermis, cellular bark, and a central axis. The others were probably low plants growing in wet places. I am not aware that they contributed to any great extent to the accumulation of coal; but as their tissues were scalariform, similar to those of ferns, it would not be easy to recognize them. A beautiful specimen of *Sphenophyllum emarginatum* from New Brunswick, in the collection of Sir W. E. Logan, has enabled me to ascertain that its stem had a simple axis of one bundle of reticulato-scalariform vessels, like those of *Tmesipteris* as figured by Brongniart. These curious plants were no doubt cryptogamous, having a habit of growth like that of *Equisetaceæ*, leaves like those of ferns or *Marsiliaceæ*, and fructification and structure like those of *Lycopodiaceæ*. They were closely allied to *Asterophyllites* and *Annularia*.

7. *Filices*.—Of the numerous species of ferns in the Carboniferous rocks of Nova Scotia, only a very few have been recognized at the Joggins. This may in part be due to the soft and crumbling character of the shales; but after much examination I am inclined to believe that the flora of the Joggins was originally poor in ferns. While the coal-field of Sydney, Cape Breton, has afforded forty-six species, the Joggins and its vicinity have as yet yielded only six or seven. Of these by far the most abundant is *Alethopteris lonchitica*, which appears throughout the Middle Coal-formation under a great number of varietal forms. It is also found abundantly at Springhill. At

* Quart. Journ. Geol. Soc. vol. x. p. 34

Sydney, on the contrary, *Pecopteris abbreviata* and *Alethopteris nervosa* are the most common ferns. But though fronds of ferns are comparatively rare at the Joggins, except in a few beds, and these holding principally the species *Alethopteris lonchitica*, bundles of scalariform vessels referable to ferns occur very plentifully in the coarser parts of the coal-beds, and would seem to indicate that vast quantities of stipes and fronds have been resolved into coal. It is to be observed, however, that it is not in all cases possible to distinguish the vascular bundles of ferns from those of the leaves of Sigillarioid and Lycopodiaceous plants. (Fig. 67, Pl. XII.)

Trunks of two species of tree ferns of the genus *Palæopteris* have been found in Nova Scotia and New Brunswick, and also obscure fragments, probably of *Caulopteris* and *Psaronius*. (Figs. 35 & 36, Pl. VIII.)

8. *Megaphyton*.—These are perhaps the most curious and puzzling plants of the coal. Their thick stems, marked by linear scars and having two rows of large depressed areoles on the sides, suggest no affinities to any known plants. They are usually ranked with *Lepidodendron*, and *Ulodendron*, but sometimes, and probably with greater reason, are regarded as allied to tree ferns. At the Joggins a very fine species (*M. magnificum*) has been found, and at Sydney a smaller species (*M. humile*); but both are rare and not well preserved. If the large scars supported cones and the smaller leaves, then, as Brongniart remarks, the plant would much resemble *Lepidophloios*, in which the cone-scars are thus sometimes distichous. But the scars are not round and marked with radiating scales as in *Lepidophloios*; they are reniform or oval, and resemble those of tree ferns, for which reason they may be regarded as more probably leaf-scars*; and in that case the smaller linear scars would indicate ramenta, or small aerial roots. Further, the plant described by Corda as *Zippea disticha* is evidently a *Megaphyton*, and the structure of that species is plainly that of a tree fern of somewhat peculiar type. On these grounds I incline to the opinion of Geinitz, that these curious trees were allied to ferns, and bore two rows of large fronds, the trunks being covered with coarse hairs or small aerial roots. At one time I was disposed to suspect that they may have crept along the ground; but a specimen from Sydney shows the leaf-stalks proceeding from the stem at an angle so acute that the stem must, I think, have been erect. From the appearance of the scars it is probable that only a pair of fronds were borne at one time at the top of the stem; and if these were broad and spreading, it would be a very graceful plant. To what extent plants of this type contributed to the accumulation of coal I have no means of ascertaining, their tissues in the state of coal not being distinguishable from those of ferns and Lycopodiaceæ.

The species *Megaphyton humile* had, like Corda's *Zippea disticha*, a thick central axis striated longitudinally, and giving off very thick bundles of fibres, and probably scalariform vessels, to the bases of the leaves. (Figs. 33 & 34, Pl. VIII.)

* This is the view of Lindley, 'Fossil Flora,' p. 116.

9. *Lepidodendron*.—Of this genus nineteen species have been recorded as occurring in the Carboniferous rocks of Nova Scotia. Of these, six occur at the Joggins, where specimens of this genus are very much less abundant than those of *Sigillaria*. In the newer Coal-formation *Lepidodendra* are particularly rare, and *L. undulatum* is the most common species. In the Middle Coal-formation *L. rimosum*, *L. dichotomum*, *L. elegans*, and *L. Pictoense* are probably the most common species; and *L. corrugatum* is the characteristic *Lepidodendron* of the Lower Carboniferous, in which plants of this species seem to be more abundant than any other vegetable remains whatever.

To the natural history of this well-known genus I have little to add, except in relation to the changes which take place in its trunk in the process of growth, and the study of which is important in order to prevent the undue multiplication of species. These are of three kinds. In some species the areoles, at first close together, become, in the process of the expansion of the stem, separated by intervening spaces of bark in a perfectly regular manner; so that in old stems, while widely separated, they still retain their arrangement, while in young stems they are quite close to one another. This is the case in *L. corrugatum* (Pl. XI.). In other species the leaf-scars or areoles increase in size in the old stems, still retaining their forms and their contiguity to each other. This is the case in *L. undulatum*, and generally in those *Lepidodendra* which have very large areoles. In these species the continued vitality of the bark is shown by the occasional production of lateral strobiles on large branches, in the manner of the modern Red Pine of America. In other species the areoles neither increase in size nor become regularly separated by growth of the intervening bark; but in old stems the bark splits into deep furrows, between which may be seen portions of bark still retaining the areoles in their original dimensions and arrangement. This is the case with *L. Pictoense*. This cracking of the bark no doubt occurs in very old trunks of the first two types, but not at all to the same extent. I figure three examples of these peculiarities in mode of growth:—

Lepidodendron corrugatum, Dawson.—I quote in the Appendix my description of this species, and may refer to the figures in Plate XI. for further illustration. I do not know any other species in Nova Scotia which has the same habit of growth; but *L. oculatum* and *L. distans* of Lesquereux show a tendency to it. The present species is exclusively Lower Carboniferous, and occurs on that horizon in New Brunswick, in Pennsylvania, and, I believe, also in Ohio; though the beds holding it in the latter State have been by some regarded as Devonian.

L. undulatum, Sternberg.—I think it not improbable that several closely allied species are included under this name. On the other hand, all the large-areoled *Lepidodendra* figured in the books must have branches with small scars, which, in the present state of knowledge, it is impossible to identify with this species. I suppose that *L. elegans* resembles the present species in its mode of growth, at least if the large-scarred specimens attributed to it are really of the same

species. *L. dichotomum* (= *L. Sternbergii*) also resembles it to some extent. (Fig. 41, Pl. IX.)

L. Pictoense, Dawson.—This species I described as follows, from young stems, in my "Synopsis of the Coal-Plants of Nova Scotia:"—"Areoles contiguous, prominent, separated in young stems by a narrow line, long-oval, acuminate; breadth to length as 1 to 3 or less; lower half obliquely wrinkled, especially at one side. Middle line indistinct. Leaf-scar at upper end of areole, small, triangular, with traces of three vascular points, nearly confluent. Length of areole about 0.5 inch."

Additional specimens from Sydney show that in old trunks of this species the areoles do not enlarge, but the bark becomes split into strips. I have reason to think that a new species from Nova Scotia which I have described in the Appendix, *L. personatum*, agrees with it in this respect. (Figs. 37, 38, and 39, Pl. IX.)

The *Lepidodendra* resemble each other too closely to admit of good subgeneric distinction. The grounds on which the distinction of *Sagenaria* and *Aspidiaria* is founded are quite worthless, the apparent position of the vascular scars in the areoles depending on accidents of preservation much more than on original differences. The genus *Knorria* includes many peculiar conditions of decorticated *Lepidodendra*.

In regard to the accumulation of coal, *Lepidodendra*, when present, appear under the same conditions with *Sigillaria*, the outer bark being converted into shining coal, and the scalariform axis appearing as mineral charcoal of a more loose and powdery quality than that derived from *Sigillaria*. On the planes of lamination of the coal the furrowed bark of old trunks can scarcely be distinguished from that of old *Sigillaria*.

10. *Lepidophloios*.—Under this generic name, established by Sternberg, I propose to include those Lycopodiaceous trees of the Coal-measures which have thick branches, transversely elongated leaf-scars, each with three vascular points and placed on elevated or scale-like protuberances, long one-nerved leaves, and large lateral strobiles in vertical rows or spirally disposed. Their structure resembles that of *Lepidodendron*, consisting of a *Sternbergia* pith, a slender axis of large scalariform vessels, giving off from its surface bundles of smaller vessels to the leaves, a very thick cellular bark, and a thin dense outer bark, having some elongated cells or bast tissue on its inner side.

Regarding *L. laricinum* of Sternberg as the type of the genus, and taking in connexion with this the species described by Goldenberg, and my own observations on numerous specimens found in Nova Scotia, I have no doubt that *Lomatophloios crassicaulis* of Corda, and other species of that genus described by Goldenberg, *Ulodendron* and *Bothrodendron* of Lindley, *Lepidodendron ornaticissimum* of Brongniart, and *Halonion punctata* of Geinitz all belong to this genus, and differ from each other only in conditions of growth and preservation. Several of the species of *Lepidostrobos* and *Lepidophyllum* also belong to *Lepidophloios*.

The species of *Lepidophloios* are readily distinguished from *Lepidodendron* by the form of the areoles, and by the round scars on the stem, which usually mark the insertion of the strobiles, though in barren stems they may also have produced branches; still the fact of my finding the strobiles *in situ* in one instance, the accurate resemblance which the scars bear to those left by the cones of the Red Pine when borne on thick branches, and the actual impressions of the radiating scales in some specimens, leave no doubt in my mind that they are usually the marks of cones; and the great size of the cones of *Lepidophloios* accords with this conclusion.

The species of *Lepidophloios* are numerous, and individuals are quite abundant in the Coal-formation, especially toward its upper part. Their flattened bark is frequent in the coal-beds and their roofs, affording a thin layer of pure coal, which sometimes shows the peculiar laminated or scaly character of the bark when other characters are almost entirely obliterated. The leaves also are nearly as abundant as those of *Sigillaria* in the coal-shales. They can readily be distinguished by their strong angular midrib.

I figure, in illustration of the genus, all the parts known to me of *L. Acadianus*, and characteristic specimens of other species. One of these, *L. parvus*, is characteristic of the Upper Coal-formation. (*Vide* Plate X. & Plate XI. fig. 51.)

11. *Cordaïtes* or *Pychnophyllum*.—This plant is represented in the Coal-formation chiefly by its broad striated leaves, which are extremely abundant in the coal and its associated shales. Some thin coals are indeed almost entirely composed of them. The most common species is *C. borassifolia*, a plant which Corda has shown to have a simple stem with a slender axis of scalariform vessels resembling that of *Lepidophloios*; for this reason, notwithstanding the broad and parallel-veined leaves, I regard this genus as belonging to *Lycopodiaceæ* or some allied family. It must have been extremely abundant in the Carboniferous swamps; and, from the frequency of its being covered with *Spirorbis*, I think it must either have been of more aquatic habit than most of the other plants of the Coal-formation, or that its leaves must have been very durable. While the leaves are abundant, the stems are very rare. I infer that they were usually low and succulent. Much of the tissue found in the coal, which I have called "epidermal," probably belongs to leaves of *Cordaïtes*.

In the Upper Coal-formation there is a second species, distinguished by its simple and uniform venation. This I have named *C. simplex*.

12. *Sporangites*.—To avoid the confusion which envelopes the classification of Carpolites, I have used the above name for rounded spore-cases of *Lepidodendron* and allied plants, which are very frequent in the coal. A smooth round species like a mustard-seed, is excessively abundant in the Lower Carboniferous at Horton, and probably belongs to *Lepidodendron corrugatum*, with which it is associated. A species covered with papillæ, *S. papillata*, constitutes nearly the whole of some layers in coal 12, group xix. of the preceding Section.

I have no indication as to the plant to which it may belong, except that it is associated with *Cordaites*. (Figs. 80 & 81, Pl. XII.)*

13. *Tissues in the Mineral Charcoal*.—On these I have little to add to the statements in my paper of 1859, "On the Vegetable Structures in Coal"†. These tissues may be arranged as follows:—

a. *Bast tissue, or elongated cells from the liber or inner bark of Sigillaria and Lepidodendron, but especially of the former*.—This kind of tissue is abundant in a calcified state in the shales associated with the coals, and also as mineral charcoal in the coals themselves, and in the interior of erect *Sigillariae*. It is the kind of tissue figured by Brongniart as the inner layer of bark in *Sigillaria elegans*, and very well described by Binney (Quart. Journ. Geol. Soc. vol. xviii.) as "elongated tissue or utricles." Under the microscope many specimens of it closely resemble the imperfect bast tissue of the inner bark of *Pinus strobus* and *Thuja occidentalis*; and like this it seems to have been at once tough and durable, remaining in fibrous strips after the woody tissues had decayed. It is extremely abundant at the Joggins in the mineral charcoal of the smaller coal-seams. It is often associated with films of structureless coal, which represent the dense cellular outer bark which, in the trunk of *Sigillaria*, not only surrounded this tissue, but was intermixed with it. (Fig. 62, Pl. XII.)

b. *Vascular bundles of Ferns*.—These may be noticed by all close observers of the surfaces of coal, as slender hair-like fibres, sometimes lying separately, in other cases grouped in bands half an inch or more in diameter, and imbedded in a loose sort of mineral charcoal. When treated with nitric acid, each bundle resolves itself into a few scalariform vessels surrounded with a sheath of woody fibres, often minutely porous. This structure is precisely that of macerated fern-stipes; but, as already stated, there may have been some other coal-plants whose leaves presented similar bundles. As stated in my former paper "On the Vegetable Structures in Coal," this kind of tissue is especially abundant in the coarse and laminated portions of the coal, which we know on other evidence to have been made up, not of trunks of trees, but of mixed herbaceous matters. (Pl. XII. fig. 67.)

c. *Scalariform vessels*.—These are very abundant in the mineral charcoal, though the coarser kinds have been crushed and broken in such a manner that they usually appear as mere débris. The scalariform vessels of *Lepidodendron*, *Lepidophloios*, and *Stigmaria* are very coarse and much resemble each other. Those of ferns are finer, and sometimes have a reticulated structure. Those of *Sigillaria* are much finer and often have the aspect of wood-cells with transversely elongated pores like those of *Cycas*. Good examples of these are figured in the paper already referred to. (See also Plate XI. figs. 54, &c.)

d. *Discigerous wood-cells*.—These are the true bordered pores

* It much resembles the spore-cases of *Flemingites gracilis*, as figured by Caruthers, 'Geol. Mag.' vol. ii. I suppose this to be a strobile of *Lepidophloios*.

† Quart. Journ. Geol. Soc. February 1860.

characteristic of *Sigillaria*, *Calamodendron*, and *Dadoxylon*. In the two former genera the disks or pores are large and irregularly arranged, either in one row or several rows. In the latter case they are sometimes regularly alternate and contiguous. In the genus *Dadoxylon* they are of smaller size and always regularly contiguous in two or more rows, so as to present an hexagonal areolation. Dis-cigerous structures of *Sigillaria* and *Calamodendron* are very abundant in the coal, and numerous examples were figured in my former paper. I have indicated by the name *Reticulated Tissue* certain cells or vessels which may either be reticulated scalariform vessels, or an imperfect form of discigerous tissue. I believe them to belong to *Stigmara* or *Calamodendron*. (Figs. 57 & 68, Pl. XII.)

e. *Epidermal tissue*.—This is a dense cellular tissue representing the outer integuments of various leaves, herbaceous stems, and fruits. I have ascertained that the structures in question occur in the leaves and stipes of *Cordaites* and ferns, and in the outer coat of *Carpolites* and *Sporangites*. With this I may include the obscure and thick-walled cellular tissue of the outer bark of *Sigillaria* and *Lepidodendron* and other trees, which, though usually consolidated into compact coal, sometimes exhibits its structure.

I would here emphatically state that all my observations at the Joggins confirm the conclusion, which I arrived at many years ago from the study of the coals of Pictou and Sydney, that the layers of clear shining coal (pitch or cherry coal) are composed of flattened trunks of trees, and that of these usually the bark alone remains; further that the lamination of the coal is due to the superposition of layers of such flattened trunks alternating with the accumulations of vegetable matter of successive years, and occasionally with fine vegetable muck or mud spread over the surface by rains or by inundations. In connexion with this, it is to be observed that the density and *impermeability* of cortical tissues not only enable them to endure after wood has perished or been resolved into bits of charcoal, but render them less liable than the wood to mineral *infiltration*.

14. *Rate of Growth of Carboniferous Plants*.—Very vague statements are often made as to the supposed rapid rate of growth of plants in the Carboniferous period. Perhaps the most trustworthy facts in relation to this subject are those which may be obtained from the coniferous trees. In some of these (for instance, *Dadoxylon materi-arium*, *D. annulatum*, and *D. antiquius*) the rings of growth, which were no doubt annual, are distinctly marked. On measuring these in a number of specimens, and comparing them with modern species, I find that they are about equal in dimensions to those of the Balsam-Fir or the Yellow Pine of America. Assuming, therefore, similarity in habit of growth and extent of foliage to these species, we may infer that, in regard to coniferous trees, the ordinary conditions of growth were not dissimilar from those of Eastern America in its temperate regions at present. When, however, we compare the ferns and *Lycopodiaceæ* of the Coal-formation with those now growing in Eastern America, we see, in the much greater dimensions and luxuriance of the former, evidence of a much

more moist and equable climate than that which now subsists; so that we may suppose the growth of such plants to have been more rapid than it is at present. These plants would thus lead us to infer a warm and insular climate, perhaps influenced by that supposed excess of carbonic acid in the atmosphere, which, as Tyndall and Hunt inform us, would promote warmth and moisture by impeding terrestrial radiation. With this would also agree the fact that the Conifers have woody tissues resembling those of the pine trees of the milder climates of the southern hemisphere at present.

If we apply these considerations to *Sigillaria*, we may infer that the conditions of moisture and uniformity of temperature favourable to ferns and *Lycopodiaceæ* were also favourable to these curious plants. They must have been perennial; and the resemblance of their trunks to those of Cycads, together with their hard and narrow leaves, would lead us to infer that their growth must have been very slow. A similar inference may be drawn from the evidences of very slow and regular expansion presented by the lower parts of their stems. On the other hand, the distance, of a foot or more, which often intervenes between the transverse rows of scars, marking probably annual fructification, would indicate a more rapid rate of growth. Further, it may be inferred, from the structure of their roots and of their thick inner bark, that these, as in Cycads, were receptacles for great quantities of starch, and that the lives of these plants presented alternations of starch-accumulation and of expenditure of this in the production of leaves, wood, and abundant inflorescence. They would thus, perhaps for several years, grow very slowly, and then put forth a great mass of fructification, after which perhaps many of the individuals would die, or again remain for a long time in an inactive state. This view would, I think, very well harmonize with the structure of these plants, and also with the mode of their entombment in the coal.

From the manner of the association of Calamites with erect *Sigillariae*, I infer that the former were, of all the plants of the Coal-formation, those of most rapid dissemination and growth. They appear to have first taken possession of emerging banks of sand and mud, to have promoted the accumulation of sediment on inundated areas, and to have protected the exposed margins of the forests of *Sigillariae*.

In applying any conclusions as to the rate of growth of Carboniferous plants to the accumulation of coal, we must take into account the probable rate of decay of vegetable matter. When we consider the probable wetness of the soils on which the plants which produced the coal grew, the density of the forests, and the possible excess of carbonic acid in the atmosphere of these swamps, we must be prepared to admit that, notwithstanding the warmth and humidity, the conditions must have been favourable to the preservation of vegetable matter. Still the hollow cylinders of bark, the little fragments of decayed wood in the form of mineral charcoal, and the detached vascular bundles of ferns, testify to an enormous amount of decay, and show that, however great the accumulation of coal, it

represents only a fraction of the vegetable matter which was actually produced. It has been estimated that it would require eight feet of compact vegetable matter to produce one foot of coal*; but if we reckon the whole vegetable matter actually produced in the process, I should suppose that five times that amount would be far below the truth, even in the most favourable cases; while there is evidence that in the Carboniferous period many forests may have flourished for centuries without producing an inch of coaly matter.

15. *Bivalve Shells*.—All the Lamellibranchiate shells, which are so numerous in some of the shales and bituminous limestones of the Joggins that some of the beds may be regarded as composed of them, belong to one generic or family group. They are the so-called Modiolas, Unios, or Anodons of authors. I proposed for them some years ago the generic name of *Naiadites*, and described six species from the Coal-measures of Nova Scotia, stating my belief that they are allied to *Unionidæ*, and that their nearest analogue may be the genus *Byssodonta* of D'Orbigny, found in the River Papana†. Mr. Salter, however, to whom I sent specimens, regards these shells as belonging to his new genera *Anthracomya* and *Anthracoptera*, the former being supposed to be allied to *Myadæ*‡. More recently Gümbel and Geinitz have described similar shells from Thuringia as belonging to the genera *Unio* and *Anodon*, and regard my *Naiadites carbonarius* (*Anthracoptera carbonaria* of Salter) as a *Dreissena*§. As these shells swarmed in the waters of the Coal-formation estuaries or lagoons, facts tending to the elucidation of their habits and affinities are important with reference to the coal; I would therefore make the following remarks in relation to them:—

(1) Under the microscope, the shells of the thicker species, as *Naiadites carbonarius*, present an internal lamellar and subnacreous layer, a thin layer of vertical prismatic shell, and an epidermis—these structures being entirely similar to those of *Unionidæ*. In the thinner species, as in *N. levis*, only the prismatic coat appears, and in this the prisms are in some instances placed obliquely. These thin shells, however, show evidence of an epidermis. (2) The ligament was external, there seem to have been no teeth, the shell was closed posteriorly; but there are indications of a byssal sinus. Mr. Salter describes the epidermis as wrinkled posteriorly; but this, with the exception of the rings of growth, appears to me to result from pressure. The shells are equivalve, and have the external aspect of *Unionidæ* or *Mytilidæ*. (3) I know of no instance in Nova Scotia of the occurrence of these shells in the strictly marine limestones, nor have any properly marine forms of Mollusca been found with *Naiadites* in the Coal-measures. (4) The mode of their occurrence precludes the idea that they were burrowers, but favours the belief that they were attached by a byssus to sunken or floating timber. On the whole I think that the balance of probability is in

* Dana's Manual, p. 367.

† Supplement to Acadian Geology, 1860.

‡ Quart. Journ. Geol. Soc. vol. xix. p. 79.

§ Neues Jahrbach, 1864. Geological Magazine, May 1865.

favour of the conclusion that they were brackish-water or fresh-water shells, allied to *Mytilidae* or to embryonic *Unionidae*.

16. *Spirorbis carbonarius*.—This little shell, which I described as a *Spirorbis* as long ago as 1845*, is apparently not specifically distinct from *Microconchus carbonarius* of the British coal-fields. Its microscopic structure is identical with that of modern *Spirorbes*, and shows that it is a true worm-shell. It is found throughout the Coal-formation, attached to plants and to shells of *Naiadites*, and must have been an inhabitant of enclosed lagoons and estuaries. Its occurrence on *Sigillariae* has been used as an argument in favour of the opinion that these trees grew in sea-water; but, unfortunately for that conclusion, the *Spirorbis* is often found on the inside of *Sigillaria*-bark, showing that this had become dead and hollow. Beside this, the same kind of evidence would prove that *Lepidodendra*, *Cordaites*, and Ferns were marine plants. *Spirorbes* multiply fast and grow very rapidly; and these little shells no doubt took immediate possession of submerged vegetation, just as their modern allies cover fronds of *Laminaria* and *Fucus*.

As I have not met with a description of this little shell, I may state that it is dextral, with $2\frac{1}{2}$ to 3 turns. It is attached throughout its length, and when not compressed presents a somewhat deep umbilicus. It is closely marked with beaded or unequal transverse ridges. It has when young a close resemblance to *Sp. caperatus*, M'Coy, from the Carboniferous Limestone of Ireland; but this species has only two turns, and is sinistral.

17. *Crustacea*.—It appears in the table above that as many as fourteen beds of coal exhibit in their roofs shells of minute Entomostraca of the genera *Cythere* and *Bairdia*; and these occur in such quantities that considerable beds of shale and bituminous limestone are filled with their valves. Professor Jones regards the species as marine or brackish-water; and the same remark will, I presume, apply to the crustacean *Diplostylus Dawsoni*, and a fragment of *Eurypterus* described by Mr. Salter from Coal no. 8 of Division 4 of the Section. Of the small Entomostracans there are several species, which Professor Jones has now in his hands for determination. No Estherians have yet been found in the Coal-formation of Nova Scotia; but I have specimens of *Leaia Leidyi* from the Lower Carboniferous of Plaister Cove, and an undetermined *Estheria* from the same horizon at Horton Bluff.

It is to be observed that *Naiadites*, *Spirorbis*, and *Cythere* constantly occur associated in the same beds; and the conclusions as to habitat applicable to any one of these genera must apply to all.

18. *Fishes*.—Remains of fishes occur in connexion with eighteen of the coal-beds at the Joggins, usually in the roof-shales, though detached scales, teeth, spines, or coprolites are of occasional though rare occurrence in the coal itself, especially where the latter passes into coarse coal or carbonaceous shale. One thin bed, no. 6 of Division 4 of the Section, is full of remains of small fishes. It is hard and laminated, and roofed with a calcareous bed full of remains

* Quart. Journ. Geol. Soc. vol. i. p. 326.

of aquatic animals. It has a true Stigmarian underclay. I suppose it to have been a swamp or forest submerged and occupied by fishes while its vegetation was still standing. It contains remains of fishes of the genera *Ctenoptychius*, *Diplocus*, *Rhizodus*, and *Palæoniscus*. It also contains *Cythere*, *Naiadites*, and *Spirorbis*. In the other beds which contain fish-remains, most of these consist of small Lepidoganoids, but there are occasional teeth and scales of large species of *Rhizodus*, and also teeth and scales of Selachian fishes of considerable size.

19. *Land-animals*.—The Coal-formation of Nova Scotia has afforded the remains of eight species of Reptiles or Batrachians, belonging to the genera *Hylonomus*, *Baphetes*, *Dendrerpeton*, *Hylerpeton*, and *Eosaurus*; of one Myriapod, *Xylobius sigillariae*; of one land snail, *Pupa vetusta*; and of one insect. All of these, except one of the reptiles, have been found at the Joggins. I have nothing in regard to them to add to what I have already published in my Memoir on 'Air-breathers of the Coal Period.'

V. APPENDIX.

Descriptive List of Carboniferous Plants found in Nova Scotia and New Brunswick.

[Abridged and corrected from "Synopsis of the Carboniferous Flora of Nova Scotia," Can. Nat. vol. viii.]*

DADOXYLON, Unger.

1. DADOXYLON ACADIANUM, spec. nov. Pl. V. figs. 4-6.

Large trees, usually silicified or calcified, with very wide wood-cells, having three or more rows of small hexagonal areoles, each enclosing an oval pore; cells of medullary rays one-third of breadth of wood-cells, and consisting of twenty or more rows of cells superimposed in two series. Rings of growth indistinct.

M. C.†, Joggins, Port Hood, Dorchester (*J. W. D.*).

2. D. MATERIARIUM, spec. nov. Pl. V. figs. 7-9.

Wood-cells less wide than those of the last; two to rarely four rows of hexagonal disks. Medullary rays very numerous, with twenty or more rows of cells superimposed in one series. Rings of growth slightly marked. Approaches in the character of its woody fibre to *D. Brandlingii*; but the medullary rays are much longer. Some specimens show a large Sternbergian pith, with transverse partitions‡. Vast numbers of trunks of this species occur in some sandstones of the Upper Coal-formation.

M. and U. C., Joggins, Malagash, Pictou, &c. (*J. W. D.*); Glace Bay (*H. Poole*); Miramichi (*G. F. Matthew*).

* The illustrations are principally from photographs by my son George M. Dawson, and for the sake of economy have been confined to small and characteristic portions of the specimens.

† U. C., M. C., and L. C., indicate the Upper, Middle, and Lower Coal-formations.

‡ Canadian Naturalist, 1857.

3. *D. ANTIQUIUS*, spec. nov. Pl. V. figs. 1-3.

Wood-cells narrow, thick-walled, two to three rows of pores. Medullary rays of three or four series of cells with twenty or more superimposed, nearly as wide as the wood-cells. Rings of growth visible. This species would belong to the genus *Palaeoxylon* of Brongniart, and is closely allied to *D. Withami*, L. and H., which, like it, occurs in the Lower Coal-measures.

L. C., Horton (*Dr. Harding*).

4. *D. ANNULATUM*, spec. nov. Pl. V. figs. 10-13.

Wood-cells with two or three rows of hexagonal disks. Medullary rays of twenty or more rows of cells superimposed, in two series. Wood divided into distinct concentric circles, alternating with layers of structureless coal representing cellular tissue or very dense wood. A stem 6 inches in diameter has fourteen to sixteen of these rings, and a pyritized pith about 1 inch in diameter. This is probably generically distinct from the preceding species.

M. C., Joggins (*Sir W. E. Logan*; *J. W. D.*).

ARAUCARITES, Unger.

ARAUCARITES GRACILIS, spec. nov. Pl. VI. fig. 14.

Branches slender, 0.2 inch in diameter, with scaly, broad leaf-bases. Branchlets pinnate, numerous, very slender, with small, acute, spirally disposed leaves.

U. C., Tatamagouche (*J. W. D.*).

SIGILLARIA, Brongn.

1. *SIGILLARIA* (FAVULARIA) *ELEGANS*, Brongn. Pl. VII. fig. 26.

Abundant, especially in the roofs of coal-seams. *S. hexagona* includes old trunks of this species. Young branches have scars of an elliptical form like those of *S. Serlii*.

M. C., Joggins (*J. W. D.*); Sydney (*R. Brown*).

2. *S.* (FAV.) *TESSELLATA*, Brongn.

M. C., Joggins and Pictou (*J. W. D.*); Sydney (*R. Brown*).

3. *S.* (RHYTIDOLEPIS) *SCUTELLATA*, Brongn. Pl. VI. fig. 25.

M. and U. C., Joggins (*Lyell*; *J. W. D.*).

4. *S.* (RH.) *SCHLOTHEIMIANA*, Brongn.

M. C., Joggins (*Lyell*; *J. W. D.*).

5. *S.* (RH.) *SAULLII*, Brongn.

M. C., Sydney (*R. Brown*); Joggins (*Lyell*; *J. W. D.*).

6. *S. BROWNII*, Dawson (Quart. Journ. Geol. Soc. vol. x.). Pl. VI. figs. 15-19.

M. C., Joggins (*J. W. D.*).

7. *S. RENIFORMIS*, Brongn.

M. C., Joggins (*Lyell*; *J. W. D.*); Sydney (*R. Brown*).

8. *S. LÆVIGATA*, Brongn.

M. C., Sydney (*R. Brown*); Joggins (*J. W. D.*).

9. *S. PLANICOSTA*, spec. nov. Pl. VI. fig. 21.

Scars half hexagonal above, rounded below; lateral vascular impressions elongate; central small, punctiform. Ribs 1.1 inch broad, smooth externally, longitudinally striated on the ligneous surface. Slight transverse wrinkles between the scars, which are distant from each other about an inch. Allied to *S. levigata*, but with very thin bark.

M. C., Sydney (*R. Brown*).

10. *S. CATENOIDES*, spec. nov. Pl. VI. fig. 22.

Cortical surface unknown; ligneous surface with puncto-striate ribs 1.1 inch in breadth, and with single oval scars half an inch long, and an inch distant from centre to centre. A very large tree. Perhaps, if its cortical surface were known, it might prove to be a large *Syringodendron*.

M. C., Joggins (*J. Smith*); Sydney (*R. Brown*).

11. *S. STRIATA*, spec. nov. Pl. VI. fig. 23.

Ribs prominent, coarsely striate, 0.35 inch wide. Scars nearly as wide as the ribs, rounded, hexagonal, 1 inch distant; lateral vascular marks narrow, central large. On the ligneous surface scars single, round, oblong; bark very thin.

M. C., Joggins (*J. W. D.*).

12. *S.* —?

A small erect stem, somewhat like *S. flexuosa*.

M. C., Joggins (*J. W. D.*).

13. *S. (CLATHRARIA) MENARDI*, Brongn.

M. C., Sydney (*R. Brown*); U. C., Pictou (*J. W. D.*).

14. *S. (ASOLANUS) SYDNENSIS*, spec. nov. Pl. VII. fig. 28.

Ribs obsolete; cortical and ligneous surfaces striate; vascular scars two, elongate longitudinally, and alike on cortical and ligneous surfaces; scars 1.1 inch distant, in rows 0.6 inch distant. Stigmarian roots, same with variety *h* of *Stigmaria*, as described below.

M. C., Sydney (*R. Brown*).

15. *S. ORGANUM*, L. & H.

M. C., Sydney (*R. Brown*).

16. *S. ELONGATA*, Brongn.

M. C., Sydney (*R. Brown*).

17. *S. FLEXUOSA*, L. & H.

M. C., Sydney (*R. Brown's list in 'Acadian Geology'*).

18. *S. PACHYDERMA*, L. & H.

M. C., Sydney (*R. Brown's list*).

19. *S. (Fav.) BRETONENSIS*, spec. nov. Pl. VII. fig. 27.

Like *S. tessellata*, but areoles more hexagonal, bark thin and smooth on both sides, and furrow above the scars arcuate and with a central punctiform elevation.

M. C., Sydney (*R. Brown*).

20. *S. EMINENS*, spec. nov. Pl. VI. fig. 24.

Like *S. obovata*, Lesqx., but with narrower ribs, and larger and less distant areoles, each with a slight groove above.

M. C., Sydney (*R. Brown*).

21. *S. DOURNANSII*, Brongn.

M. C., Joggins (*J. W. D.*).

22. *S. KNORRII*, Brongn.

M. C., Sydney (*R. Brown*).

SYRINGODENDRON, Brongn.

Obscure specimens, referable to a narrow-ribbed species of this genus, occur in the Lower Carboniferous beds at Horton and Onslow.

STIGMARIA, Brongn.

STIGMARIA FICOIDES, Brongn. Pl. XII. fig. 83-87.

Under this name I place all the roots of *Sigillaria* occurring in the Carboniferous rocks of Nova Scotia. They belong, without doubt, to the different species of Sigillarioid trees; but it is at present impossible to determine to which; and the specific characters of the *Stigmarie* themselves are, as might be anticipated, evanescent and unsatisfactory. The varieties which occur in Nova Scotia, discarding mere difference of preservation, may be arranged as follows:—

Var. *a.* Areoles large, distant; bark more or less smooth. This is the most common variety, and extends throughout the Coal-formation.

Var. *b.* Areoles large, separated by waving grooves of the bark.

Var. *c.* Similar, but ridges as well as furrows between the areoles; var. *undulata* of Goeppert.

Var. *d.* Areoles small, separated by waving grooves.

Var. *e.* Areoles moderate, in vertical or diagonal furrows separated by ridges; var. *sigillarioides* of Goeppert.

Var. *f.* Areoles small; bark finely netted with wrinkles or striæ.

Var. *g.* Areoles surrounded by radiating marks, giving a star-like form; var. *stellata* of Goeppert. The only specimen I have seen was found by Dr. Harding in the Lower Carboniferous Coal-measures of Horton.

Var. *h.* Areoles small, or obscure and infrequent. Surface covered with fine uneven striæ. My specimens were collected by Mr. Brown in the Middle Coal-measures at Sydney.

Var. *i.* Areoles narrow, elongate, bark smooth or striate.

Var. *k.* *alternans*, with areoles in double rows on broad ribs separated by deep furrows. Probably old furrowed roots.

Var. *l. Knorroides*. Prominent bosses or ridges instead of areoles. These are imperfectly preserved specimens.

The varieties *a, b, c, e, i*, have been seen attached to trunks of *Sigillaria* of the group distinguished by broad and prominent ribs—*Sigillaria* proper of the above arrangement. *Stigmariæ*, like *Sigillariæ*, are exceedingly abundant in the Middle Coal-measures, and are comparatively rare in the Lower Carboniferous and newer Coal-formations.

CALAMODENDRON, Brongn.

1. CALAMODENDRON APPROXIMATUM, Brongn. Pl. VII. fig. 31.

This plant is evidently quite distinct from *Calamites* proper. The Calamite-like cast is a pith or internal cavity, surrounded by a thick cylinder of woody tissue consisting of scalariform vessels and woody fibres with one row of round pores; external to this is a bark of cellular and bast tissue. The structure appears to be allied to that of *Sigillaria*, and is one of the most common in the beds of bituminous coal.

M. C., Sydney (*R. Brown*); M. C., Joggins, Pictou (*J. W. D.*); Coal Creek (*C. B. Matthew*).

2. C. OBSCURUM, spec. nov. Pl. VII. fig. 31 d.

This is a Calamite-like fragment found in a block of Sydney coal, in the state of mineral charcoal. The external markings are obscure, but the structure is well preserved. It differs from the last in having large ducts with many rows of pores, or reticulated instead of scalariform vessels. This is perhaps a Calamite.

M. C., Sydney (*J. W. D.*).

CYPERITES, L. & H.

CYPERITES — ?

These elongate linear leaves have two or three ribs, and the central band between the ribs raised above the margin; one species has been seen attached to *Sigillaria Schlotheimiana*.

The leaves of *Sigillaria elegans* are different, being as broad as the areoles of the stem, and with several parallel veins.

Middle and upper coals, everywhere.

ANTHOLITHES, Brongn.

1. ANTHOLITHES RHABDOCARPI, spec. nov. Pl. VII. fig. 30.

Stem short, interruptedly striate, with two rows of crowded ovate fruits, and traces of floral leaves. Fruits half an inch long, striated longitudinally, attached by short peduncles.

M. C., Grand Lake (*C. F. Hartt*).

2. A. PYGMÆA, spec. nov. Pl. VII. fig. 30 c.

Rhachis 1 inch thick, rugose; two rows of opposite flowers, each showing four lanceolate striate floral leaves, two outer and two inner.

M. C., Joggins (*J. W. D.*).

3. *A. SQUAMOSA*, spec. nov. Pl. VII. fig. 29.

Rhachis thick, coarsely rugose, with two rows of closely placed cones or scaly fruits.

U. C., Pictou (*J. W. D.*).

4. *A.* —? , spec. nov.

Indistinct, but apparently different from those above described.

M. C., Joggins (*J. W. D.*); Sydney (*R. Brown*).

TRIGONOCARPUM, Brongn.

1. *TRIGONOCARPUM* *HOOKEI*, Dawson, Quart. Journ. Geol. Soc. vol. xvii.

M. C., Mabou (*J. W. D.*).

2. *T. SIGILLARIÆ*, spec. nov. Pl. XII. fig. 76.

Ovate, $\frac{1}{4}$ inch long; testa smooth, or rugose longitudinally, acuminate, two-edged. Found in erect trunks of *Sigillariæ* in large numbers.

M. C., Joggins (*J. W. D.*).

3. *T. INTERMEDIUM*, spec. nov. Pl. XII. fig. 78.

Allied to *T. olivæformis*, but larger and more elongated.

M. C., Joggins, (*J. W. D.*).

4. *T. AVELLANUM*, spec. nov. Pl. XII. fig. 77.

Allied to *T. ovatum*, L. & H.; three-ribbed, size and form of a filbert.

M. C., Joggins (*J. W. D.*); Sydney (*R. Brown*).

5. *T. MINUS*, spec. nov. Pl. XII. fig. 75.

Half the size of *T. Hookeri*, and similar in form.

M. C., Joggins (*J. W. D.*).

6. *T. ROTUNDUM*, spec. nov.

Small, round-ovate, slightly pointed.

M. C., Joggins (*J. W. D.*).

7. *T. NÆGGERATHI*, Brongn.

Newer Coal-formation, Pictou (*J. W. D.*).

RHABDOCARPUS, Goepp. and Bergm.

1. *RHABDOCARPUS* —? , spec. nov.

Ovate acuminate, less than half an inch long.

M. C., Joggins (*J. W. D.*).

2. *R. INSIGNIS*, spec. nov. Pl. XII. fig. 69.

1.5 inch long, ovate, smooth, with about seven ribs on one side, and the intervening surface obscurely striate. The nature of this fossil is perhaps doubtful; but if a fruit, it is the largest I have seen in the Coal-formation.

U. C., Pictou (*J. W. D.*).

CALAMITES, Suckow.

1. CALAMITES SUCKOVII, Brongn.

This species is one of the most common in an erect position. It has verticillate branchlets, with pinnate linear leaflets.

M. C., Sydney (*R. Brown*); Joggins (*Lyell*; *J. W. D.*); Grand Lake (*C. F. Hartt*); U. C., Pictou (*J. W. D.*); Coal Creek (*C. B. Matthew*).

2. C. CISTII, Brongn.

M. C., Joggins (*J. W. D.*); Sydney (*R. Brown*); Grand Lake (*C. F. Hartt*); Bay de Chaleur (*Logan*); Coal Creek (*C. B. Matthew*).

Often found erect. Its leaves are verticillate, simple, linear, striate, apparently one-nerved, and 3 inches long.

3. C. CANNÆFORMIS, Brongn.

M. C., Joggins (*Lyell*; *J. W. D.*); Sydney (*R. Brown*).

4. C. RAMOSUS, Artis.

Possibly a variety of *C. Suckovii*.

M. C., Joggins (*J. W. D.*); Sydney (*R. Brown*).

5. C. VOLTZII, Brongn. (*C. irregularis*, L. & H.)

M. C., Joggins (*J. W. D.*).

Often erect; has large irregular adventitious roots. This species is regarded by Brongniart as probably belonging to *Calamodendron*.

6. C. DUBIUS, Artis.

M. C., Sydney (*R. Brown*); Joggins (*J. W. D.*; *Logan*); U. C., Pictou (*J. W. D.*).

7. C. NOVA-SCOTICA, spec. nov. Pl. XII. fig. 89.

M. C., Joggins (*J. W. D.*).

Ribs equal, less than a line wide, striated longitudinally. Joints obscurely marked, and with circular areoles separated by the breadth of three to four ribs. Bark of moderate thickness.

8. C. NODOSUS, Schloth.

This species has long slender branchlets, with close whorls of short rigid leaves.

M. C., Sydney (*R. Brown*); Grand Lake (*C. F. Hartt*).

9. C. ARENACEUS (?), Jäger.

This species is mentioned with doubt in Lyell's list.

EQUISETITES, Sternberg.

EQUISETITES CURTA, spec. nov. Pl. XII. fig. 88.

Short thick stems, enlarging upward, and truncate above; joints numerous; sheaths as long as the joints, with unequal acuminate keeled points. Lateral branches or fruit with longer leaf-like points. Has the characters of *Equisetites*; but its affinities are quite uncertain.

M. C., Sydney (*R. Brown*).

ASTEROPHYLLITES, Brongn.

1. ASTEROPHYLLITES FOLIOSA, L. & H.
M. C., Joggins (*J. W. D.*); Sydney (*R. Brown*).
2. A. EQUISETIFORMIS, L. & H.
M. C., Sydney (*R. Brown*); Pictou (*J. W. D.*).
3. A. GRANDIS, Sternberg?

The specimens resemble this species, but are not certainly the same. Logan's specimens have terminal spikes of fructification.

M. C., Grand Lake (*C. F. Hartt*); Bay de Chaleur (*Logan*); Sydney (*Bunbury*).

4. ASTEROPHYLLITES, sp.

A species with tubercles (fruit) in the axils is mentioned in Lyell's list as from Sydney. I have not seen it, but have a specimen from Mr. Brown similar to *A. tuberculata*, Sternberg, which may be the same.

5. A. TRINERVIS, spec. nov. Pl. XIII. fig. 90.

Main stem smooth, delicately striate, with leaves at the nodes. Branches delicately striate, with numerous whorls of linear nearly straight leaves, 0·5 inch long, twenty or more in a whorl, and showing two lateral nerves in addition to the median nerve. This and *A. equisetiformis* would be placed by some authors in *Annularia*.

M. C., Sydney (*R. Brown*).

ANNULARIA, Sternberg.

ANNULARIA GALIOIDES, Zenker.

M. C., Grand Lake (*C. F. Hartt*); U. C., Pictou (*J. W. D.*); Bay de Chaleur (*Logan*); Sydney (*R. Brown*).

SPHENOPHYLLUM, Brongn.

1. SPHENOPHYLLUM EMARGINATUM, Brongn.
M. C., Sydney (*R. Brown*); Grand Lake (*C. F. Hartt*); Bay de Chaleur (*Logan*); Pictou (*J. W. D.*).
2. S. LONGIFOLIUM, Germar.
U. C., Pictou (*J. W. D.*); M. C., Sydney (*R. Brown*).
3. S. SAXIFRAGIFOLIUM, Sternberg.
Elongate much-forked variety, closely allied to *S. bifurcatum*, Lesquereux.
Bay de Chaleur (*Logan*).
4. S. SCHLOTHEIMII, Brongn.
M. C., Sydney (*Bunbury*).
5. S. EROSUM, L. and H.
M. C., Sydney (*Bunbury*).

The last two species are regarded by Geinitz as varieties of *S. emarginatum*. A specimen of the last-named species in Sir William

Logan's collection shows a woody jointed stem like that of *Asterophyllites*, giving off branches at the joints; these again branch and bear whorls of leaves. The stem shows under the microscope a single bundle of reticulated or scalariform vessels like those of some ferns, and also like those of *Tmesipteris*, as figured by Brongniart. This settles the affinities of these plants as being with ferns or with *Lycopodiaceæ*.

PINNULARIA, L. & H.

1. PINNULARIA CAPILLACEA, L. & H.

M. C., Sydney (*R. Brown*).

2. P. RAMOSISSIMA, spec. nov.

More slender and ramose than the last.

M. C., Joggins (*J. W. D.*).

3. P. CRASSA, spec. nov.

Branching like *P. capillacea*, but much stronger and coarser.

L. C., Horton (*C. F. Hartt*).

All these are apparently branching fibrous roots, of soft cellular tissue with a thin epidermis and slender vascular axis. Perhaps they are roots of *Asterophyllites*.

Genus NÆGGERATHIA, Sternberg.

1. NÆGGERATHIA DISPAR, spec. nov. Pl. XIII. fig. 91.

A remarkable fragment of a leaf, with a petiole nearly 3 inches long, and a fourth of an inch wide, spreading abruptly into a lamina, one side of which is much broader than the other, and with parallel veins running up directly from the margin as from a marginal rib. It appears to be doubled in at both edges, and is abruptly broken off. It seems to be a new species; but of what affinities, it is impossible to decide.

Bay de Chaleur (*Sir W. E. Logan*).

2. N. FLABELLATA, L. & H.

M. C., Sydney (*R. Brown*).

CYCLOPTERIS, Brongn.

(including *Cyclopteris* proper, and subgenera *Aneimites*, Daws., and *Neuropteris*, Brongn.).

1. CYCLOPTERIS HETEROPHYLLA, Goeppert.

M. C. and U. C., Joggins (*J. W. D.*).

2. C. (ANEIMITES) ACADICA, Dawson, Quart. Journ. Geol. Soc. vol. xvii. p. 5. Pl. VIII. fig. 32.

Stipe large, striate, branching dichotomously several times. Pinnæ with several broadly obovate pinnules grouped at the end of a slender petiolule, and with dichotomous radiating veins. Fertile pinnæ with recurved petiolules, and borne on the divisions of the main petiole near their origin. This plant might be placed in the genus *Adiantites*, Brongn., but for the fructification, which allies it

with such ferns as *Ancimia*. It has a very large frond, the main petiole being sometimes 3 inches in diameter, and 2 feet long before branching. Flattened petioles have sometimes been mistaken for *Cordaites* and *Schizopteris*. It is a characteristic plant of the Lower Coal-measures.

L. C., Horton (*C. F. Hartt*); Norton Creek, N.B. (*G. F. Matthew*).

3. *C. OBLONGIFOLIA*, Goeppert.

A little larger and coarser than Goeppert's figure.

U. C., Pictou (*J. W. D.*).

4. *C. (NEUROPTERIS) OBLIQUA*, Brongn.

M. C., Sydney (*R. Brown*); Grand Lake (*C. F. Hartt*).

5. *C. (?NEUROPTERIS) INGENS*, L. & H.

M. C., Sydney (*R. Brown*); Grand Lake (*C. F. Hartt*).

6. *C. OBLATA*, L. & H.

M. C., Sydney (*R. Brown*).

7. *C. FIMBRIATA*, Lesquereux.

M. C., Sydney (*R. Brown*).

8. *C. HISPIDA*, spec. nov. Pl. XIII. fig. 92.

Pinnate; pinnules obovate, diminishing in size towards the point, decurrent on the petiole; veins slender, distant, forking several times; under surface covered with stiff hairs.

M. C., Sydney (*R. Brown*).

9. *C. ANTIQUA*, spec. nov. Pl. XIII. fig. 95.

L. C., ? Hebert River (*J. W. D.*).

Tripinnate; petioles slender; pinnules oblong, obtuse, decurrent on the petiole, not contiguous. Terminal pinnules much elongated; venation simple, divergent. This plant approaches more nearly to the peculiar species of *Cyclopteris* found in the Devonian, than any of the others I have seen in the Carboniferous.

NEUROPTERIS, Brongn.

1. *NEUROPTERIS RARINERVIS*, Bunbury.

M. C., Sydney (*R. Brown*); Grand Lake (*C. F. Hartt*); Bay de Chaleur (*Logan*).

2. *N. PERELEGANS*, spec. nov. Pl. XIII. fig. 93.

M. C., Sydney (*R. Brown*).

Resembles *N. elegans*, Brongn., but has narrower pinnules, and nerves less oblique to the midrib. The pinnules were thick and leathery, rough or cellular-netted above, and showing the venation only on the underside.

3. *N. CORDATA*, Brongn. (and var. *angustifolia*).

The ferns referred to this species are identical with *N. hirsuta* of Lesquereux. They abound in the Middle and Upper Coal-formations, and have larger pinnules than any of the other ferns. A

single terminal pinnule in my collection is 5 inches long. The surface is always more or less hairy.

M. C., Sydney (*R. Brown*); U. C., Pictou (*J. W. D.*).

4. *N. VOLTZII*, Brongn.

A single imperfect specimen like this species, but uncertain.

M. C., Pictou (*J. W. D.*).

5. *N. GIGANTEA*, Sternb.

M. C., Sydney (*R. Brown*); Grand Lake (*C. F. Hartt*); U. C., Pictou (*J. W. D.*).

6. *N. FLEXUOSA*, Sternb.

M. C., Sydney (*R. Brown*); Joggins (*J. W. D.*).

7. *N. HETEROPHYLLA*, Brongn.

M. C., Sydney (*R. Brown*); U. C., Pictou (*J. W. D.*).

9. *N. LOSHII*, Brongn.

Bay de Chaleur (*Logan*).

10. *N. ACUTIFOLIA*, Brongn.

M. C., Sydney (*Lyell's list*).

11. *N. CONJUGATA*, Goepf.

M. C., Sydney (*Brown's list, Acad. Geol.*).

12. *N. ATTENUATA*, L. & H.

M. C., Sydney (*l. c.*).

13. *N. DENTATA*, Lesq.

M. C., Sydney (*R. Brown*).

14. *N. SORETHII* (Brongn.).

M. C., Sydney (*R. Brown*).

15. *N. AURICULATA*, Brongn.

M. C., Sydney (*R. Brown*).

16. *N. CYCLOPTEROIDES*, spec. nov. Pl. XIII. fig. 94.

Pinnate; pinnules contiguous or overlapping, obliquely round-ovate, attached at the lower third of the base; nerves numerous, spreading from the point of attachment. Allied to *N. Villiersi*, Brongn.

M. C., Sydney (*R. Brown*).

ODONTOPTERIS, Brongn.

1. *ODONTOPTERIS SCHLOTHEIMII*, Brongn.

M. C., Sydney (*R. Brown*); Bay de Chaleur (*Logan*); U. C., Pictou (*J. W. D.*).

2. *O. SUBCUNEATA*, Bunbury.

M. C., Sydney (*R. Brown*).

DICTYOPTERIS, Gutb.

DICTYOPTERIS OBLIQUA, Bunbury.

M. C., Sydney (*R. Brown*).

LONCHOPTERIS, Brongn.

LONCHOPTERIS TENUIS, spec. nov. Pl. XIII. fig. 103.

Pinnate or bipinnate; pinnules contiguous at the base, nearly at right angles to petiole, oblong elongate, obtuse. Network of veins very delicate. Allied to *L. Bricii*, Brongn., but with smaller, more elongate pinnules and finer veins. I suspect this to be a thick-leaved *Pecopteris*, showing a coarse cellular reticulation on the upper surface.

M. C., Sydney (*R. Brown*).

SPHENOPTERIS, Brongn.

1. SPHENOPTERIS MUNDA, spec. nov. Pl. XIII. fig. 97.

Like *S. Dubuissonii*, Brongn., or *S. irregularis*, Sternberg, in habit; but the pinnules are obovate, decurrent, and few-veined.

M. C., Grand Lake (*C. F. Hartt*).

2. S. HYMENOPHYLLOIDES, Brongn.

M. C., Sydney (*R. Brown*); U. C., Joggins (*J. W. D.*).

3. S. LATIOR, spec. nov. Pl. XIII. fig. 98.

Petiole forking at an obtuse angle, slender, tortuous; divisions bipinnate; pinnæ with broad, rounded, confluent pinnules; veins twice forked, with sori in the forks of the veins. In habit like *S. latifolia*, Brongn., *S. Newberryi*, and *S. squamosa*, Lesq.

M. C., Grand Lake (*C. F. Hartt*); U. C., Pictou (*J. W. D.*).

4. S. DECIPiens, Lesquereux.

M. C., Sydney (*R. Brown*).

5. S. GRACILIS, Brongn.

M. C., Joggins (*J. W. D.*); Grand Lake (*C. F. Hartt*).

6. S. ARTEMISIFOLIA, Brongn.

M. C., Grand Lake (*C. F. Hartt*); Sydney (*R. Brown*).

7. S. CANADENSIS, spec. nov. Pl. XIII. fig. 99.

General aspect like *S. Haeninghausi*, but secondary pinnules with a margined petiole, and oblong pinnules divided into three to five obtuse points. It is not unlike *S. marginata*, from the Devonian of St. John.

Bay de Chaleur (*Logan*); Sydney? (*R. Brown*).

8. S. LESQUEREUXII, Newberry.

M. C., Sydney (*R. Brown*).

9. S. MICROLOBA, Guttbier.

M. C., Sydney (*R. Brown*).

10. S. OBTUSILOBA (?), Brongn.

M. C., Bay de Chaleur (*Logan*).

PHYLLOPTERIS, Brongn.

PHYLLOPTERIS ANTIQUA, spec. nov. Pl. XIII. fig. 96

Pinnate; petiole thick, woody; pinnules oblong, pointed, attached by the middle of the base; midrib strong, extending to the point, giving off very oblique nerves, which have obliquely pinnate nervules not anastomosing. A remarkable frond, which, if not the type of a new genus, must belong to that above named.

M. C., Sydney (*R. Brown*).

ALETHOPTERIS, Sternberg.

1. ALETHOPTERIS LONCHITICA, Sternberg.

M. and U. C., Joggins (*J. W. D.*); M. C., Sydney (*R. Brown*); Grand Lake (*C. F. Hartt*).

Very abundant throughout the Middle and Upper Coal-formations, and so variable that several species might easily be founded on detached specimens.

2. A. HETEROPHYLLA, L. & H.

L. C., Parrisborough (*A. Gesner*).

3. A. GRANDINI, Brongn.

M. C., Sydney (*R. Brown*).

4. A. NERVOSA, Brongn.

M. C., Sydney (*R. Brown*); Bay de Chaleur (*Logan*); U. C., Pictou (*J. W. D.*).

5. A. MURICATA, Brongn.

M. C., Joggins, Bathurst (*Lyell*); U. C., Pictou (*J. W. D.*).

6. A. PTEROIDES, Brongn. (*A. Brongnartii*, Goepfert).

L. or M. C., Bathurst (*Lyell's list*).

7. A. SERLII, Brongn.

M. C., Sydney (*R. Brown*); Bay de Chaleur (*Logan*).

8. A. GRANDIS, spec. nov. Pl. XIII. fig. 100.

Bipinnate; pinnae broad, contiguous, united at the base; veins numerous, once forked, not quite at right angles to the midrib. Upper pinnae having the pinnules confluent so as to give crenate edges. Still higher the apex of the frond shows distant decurrent long pinnules with waved margins. A very large and fine species of the type of *A. Serlii* and *A. Grandini*, but much larger and different in details. Its texture seems to have been membranaceous; and fragments from that part of the frond where the long simple pinnules are passing into the compound ones might be mistaken for an *Odontopteris*.

Bay de Chaleur (*Logan*).

PECOPTERIS, Brongn.

1. PECOPTERIS ARBORESCENS, Schloth.

Seems to have been an herbaceous species with a very strong

petiole. It occurs in an erect position in a sandstone on Wallace River.

M. C., Sydney (*R. Brown*); U. C., Pictou (*J. W. D.*); Wallace River (*Dr. Creed*).

2. *P. ABBREVIATA*, Brongn.

M. C., Sydney (*R. Brown*); Salmon River, U. C., Pictou (*J. W. D.*).
Very common both in the Upper and Middle Coal-formations.

3. *P. RIGIDA*, spec. nov.

Similar to *P. arborescens*, but much smaller, and with finer nerves.
U. C., Pictou (*J. W. D.*).

4. *P. UNITA*, Brongn.

Certain pinnules of a frond are sometimes swollen as if covered with fructification below; and in this state they resemble *P. arguta*, Brongn. The sori are seen in other specimens, and are large, round, and covered with an indusium as in *Aspidium*.

M. C., Sydney (*R. Brown*); U. C., Pictou (*J. W. D.*).

5. *P. PLUMOSA*, Brongn.

M. C., Sydney (*R. Brown*).

6. *P. POLYMORPHA*, Brongn.

M. C., Sydney (*R. Brown*).

7. *P. ACUTA*, Brongn.

M. C., Pictou (*J. W. D.*).

8. *P. LONGIFOLIA*, Brongn.

In Bunbury's list, from Sydney.

9. *P. TENIOPTEROIDES*, Bunbury.

M. C., Sydney (*R. Brown*).

10. *P. CYATHEA*, Brongn.

M. C., Sydney (*R. Brown*).

11. *P. ÆQUALIS*, Brongn.

M. C., Sydney (*R. Brown*).

12. *P. SILLIMANI*?, Brongn.

In Lyell's list, from Sydney.

13. *P. VILLOSA*, Brongn.

M. C., Pictou (*Lyell's list*).

14. *P. BUCKLANDI*, Brongn.

M. C., Sydney (*Brown's list*).

15. *P. OREOPTEROIDES*, Brongn.

M. C., Sydney (*Brown's list*).

16. *P. DECURRENS*, Lesq.

Has pinnules more crowded, decreasing towards the apex, but may be a variety.

M. C., Sydney (*R. Brown*).

17. *P. PLUCKENETII*, Sternb.

M. C., Sydney (*R. Brown*).

BEINERTIA, Goeppert.

BEINERTIA GOEPPERTI, spec. nov. Pl. XIII. fig. 101.

Bipinnate; pinnae broad, contiguous, obtuse, with thick pinnules. Pinnules rounded above, obovate below. Midrib thick, oblique, dividing above into a tuft of irregular hair-like veins.

M. C., Grand Lake (*C. F. Hartt*); Bay de Chaleur (*Logan*); U. C., Joggins (*J. W. D.*).

HYMENOPHYLLITES, Goeppert.

HYMENOPHYLLITES PENTADACTYLA, spec. nov.

In general habit like *Sphenopteris microloba*, Goepp., but with pinnules divided into from four to seven obtuse cuneate lobes, each with one vein.

M. C., Sydney (*R. Brown*).

PALÆOPTERIS, Geinitz.

1. PALÆOPTERIS HARTII, spec. nov. Pl. VIII. fig. 35.

Stem or leaf-bases transversely wrinkled with delicate lines; scars transversely oval, slightly appendaged below; vascular scars confluent. Breadth 1.4 in.; length 0.6 in.

M. C., Grand Lake (*C. F. Hartt*).

2. *P. ACADICA*, spec. nov. Pl. VIII. fig. 36.

Stem or leaf-bases longitudinally striated; scars transverse, flat above, rounded and bluntly appendaged below; vascular scars in a transverse row. Breadth of scars 0.7 inch; length 0.5 inch.

U. C., Pictou (*J. W. D.*).

CAULOPTERIS, L. & H.

Several small erect stems at the Joggins seem to be trunks of ferns, but are too obscure for description.

PSARONIUS, Cotta.

Trunks of this kind must be rare in the Nova Scotian coal-fields. A few obscure stems surrounded by cord-like aerial roots have been found, and probably are remains of plants of this genus.

MEGAPHYTON, Artis.

1. MEGAPHYTON MAGNIFICUM, spec. nov. Pl. VIII. fig. 34.

Stems large, roughly striated longitudinally; scars contiguous, orbicular, deeply sunk, nearly 3 inches in diameter, and each with a bilobate vascular impression 2 inches broad and an inch high.

M. C., Joggins (*J. W. D.*).

2. *M. HUMILE*, spec. nov. Pl. VIII. fig. 33.

Stem 2·5 inches in diameter; leaf-scars prominent, flattened, and broken at the ends, 1 inch wide. Surface of the stem marked with irregular furrows, and invested with a carbonaceous coating. An internal axis, nearly 2 inches in diameter, with a coaly coating, sends off obliquely thick branches to the leaf-scars. This is a very remarkable specimen, and throws much light on the structure of *Megaphyton*. Unfortunately the minute structures are not preserved.

M. C., Sydney (*R. Brown*).

Genus *LEPIDODENDRON*, Sternberg.1. *LEPIDODENDRON CORRUGATUM*, Dawson, Quart. Journ. Geol. Soc. vol. xv. Pl. XI. fig. 53.

Areoles elongate ovate, acute at both ends, with a ridge along the middle, terminating in a single elevated vascular scar at the upper end. In certain states the vascular mark appears in the middle of the areole. In young branches the areoles are contiguous and resemble those of *L. elegans*. In old stems they become separated by spaces of longitudinally wrinkled bark; in very old stems these spaces are much wider than the areoles. Leaves linear, 1 inch or more in length, usually reflected, one-nerved. Cones (*Lepidostrobi*) terminal, short, cylindric, with numerous short, acute-triangular scales. Structure of stem:—a central pith with a slender cylinder of scalariform vessels, exterior to which is a thick cylinder of cellular tissue and bast fibres, and a dense outer bark.

Var. *verticillatum* has the areoles arranged in regular decussate whorls instead of spirally. This difference, which might at first sight seem to warrant even a generic distinction, is proved by specimens in my possession to be merely a variety of *phyllotaxis*.

This species is eminently characteristic of the Lower Carboniferous Coal-measures, and has not yet been found in the Middle Coal-formation. Fragments of bark resembling that of this species, occur in the Coal-formation of Bay de Chaleur, along with leafy branches of *Lepidodendron*, which resemble those of this species, though, I believe, distinct.

L. C., Horton, &c. (*C. F. Hartt*; *J. W. D.*); Norton Creek, &c., New Brunswick (*G. F. Matthew*).

2. *L. PICTOENSE*, spec. nov. Pl. IX. fig. 37.

Areoles contiguous, prominent, long oval, acuminate, separated in young stems by a narrow line; breadth to length as 1 to 3, or less; lower half obliquely wrinkled, especially at one side. Middle line indistinct. Leaf-scar at upper end of areole, small, triangular, with traces of three vascular points, nearly confluent. Length of areole about 0·5 inch. Leaves contracted at the base, widening slightly, and gradually contracting to a point; ribs three, central distinct, lateral obscure; length 1 inch. Cones borne at the extremities of the smaller branches, oblong, obscurely scaly.

In habit of growth this species resembles *L. elegans*, for which

imperfect specimens might be mistaken. It is also near to *L. binerve* and *L. patulum*, Bunbury*. It abounds in the Middle Coal-measures.

M. C., Sydney (*R. Brown*); Pictou (*H. Poole and J. W. D.*); Grand Lake (*C. F. Hartt*).

3. *L. RIMOSUM*, Sternberg.

M. C., Sydney (*R. Brown*); Joggins (*J. W. D.*).

4. *L. DICHOTOMUM*, Sternberg (*L. Sternbergii*, L. & H.).

M. C., Sydney (*R. Brown*); Joggins (*J. W. D.*); L. C., Horton, (*J. W. D.*).

5. *L. DECURTATUM*, spec. nov. Pl. IX. fig. 40.

Areoles approximate or separated by a shallow furrow, rhombic ovate, obliquely acuminate below, nearly as broad as long, wrinkled transversely, especially on the middle line, which appears tuberculated; vascular scar rhombic, twice as broad as long, with three approximate vascular points. In some flattened specimens the line separating the areoles is indistinct, and the scars appear on a transversely wrinkled surface without distinct areoles.

M. C., Pictou (*J. W. D.*).

6. *L. UNDULATUM*, Sternberg. Pl. IX. fig. 41.

Possibly several species are included under this name; but they cannot be separated at present.

M. C., Sydney (*R. Brown*); Joggins and Pictou (*J. W. D.*); U. C., Joggins (*J. W. D.*).

7. *L. DILATATUM*, Lindley & Hutton.

M. C., Joggins (*J. W. D.*).

8. *L.*, sp. like *TETRAGONUM*, Goepp.

Obscurely marked, but a distinct species, unless an imperfectly preserved variety of *L. tetragonum*. The areoles are square, with a rhombic scar at the upper corner of each.

L. C., Horton (*J. W. D.*).

9. *L. BINERVE*, Bunbury.

M. C., Sydney (*R. Brown*).

10. *L. TUMIDUM*, Bunbury.

I think it probable that this species belongs to the genus *Lepidophloios*; but I have not seen a specimen.

M. C., Sydney (*R. Brown*).

11. *L. GRACILE*, Brongn.

In Brown's list in 'Ac. Geology.' Probably a variety of the next.

M. C., Sydney (*R. Brown*).

12. *L. ELEGANS*, Brongn.

In Bunbury and Brown's lists.

M. C., Sydney (*R. Brown*).

* In certain states of preservation, the lateral ribs of the leaves become obsolete; and in others the central disappears, in which state the resemblance to *L. binerve* is very close.

13. *L. PLUMARIUM*, L. & H.M. C., Sydney (*in Brown's list*).14. *L. SELAGINOIDES*, Sternb.M. C., Sydney (*in Brown's list*).15. *L. HARCOURTII* (Witham).M. C., Sydney (*in Brown's list*).16. *L. CLYPEATUM* (?), Lesqx.M. C., Sydney (*R. Brown*); U. C., Joggins (*J. W. D.*).17. *L. ACULEATUM*, Sternberg.M. C., Sydney (*R. Brown*).18. *L. PLICATUM*, spec. nov. Pl. IX. fig. 38.

Leaf-areoles much elongated; breadth to length as 1 to 5 or 6, transversely rugose; central line indistinct. Leaf-scar rhombic, with three vascular points; scars in old stems separated by rugose bark, and somewhat elongate.

M. C., Pictou (*J. W. D.*).19. *L. PERSONATUM*, spec. nov. Pl. IX. fig. 39.

Areoles ovate acuminate; breadth to length as 1 to 3 or 4, contiguous in young stems; central lines distinct; lower part of areole with transverse lines. Leaf-scars ovate, with two marks above and two below; leaves slender, 1 inch long, one-nerved.

M. C., Sydney (*R. Brown*).*HALONIA*, sp.*HALONIA*, L. & H.

A specimen probably referable to this genus from Grand Lake, in the collection of C. F. Hartt.

LEPIDOSTROBUS, Brongn.1. *LEPIDOSTROBUS VARIABILIS*, L. & H.

The most common species.

M. C., Sydney (*R. Brown*); Pictou and Joggins (*J. W. D.*).2. *L. SQUAMOSUS*, spec. nov. Pl. 10. fig. 46.

2 to 3 inches long, 1 inch thick; scales large, broadly trigonal, acute. Allied to *L. trigonolepis*, but larger. Probably a cone of *Lepidophloios*.

M. C., Grand Lake (*C. F. Hartt*).3. *L. LONGIFOLIUS*, spec. nov.Long-leaved, like *Lepidodendron longifolium*, L. & H.M. C., Joggins (*J. W. D.*).4. *LEPIDOSTROBUS*, sp.

Acute trigonal leaves, small.

M. C., Joggins (*J. W. D.*).5. *LEPIDOSTROBUS*, sp.

Round, with obscure scales and remains of long leaves.

L. C., Horton (*J. W. D.*).

6. *L. TRIGONOLEPIS*, Bunbury.
M. C., Sydney (*R. Brown*).

LEPIDOPHYLLUM, Brongn.

1. *LEPIDOPHYLLUM LANCEOLATUM*, L. & H.
M. C., Joggins; U. C., Pictou (*J. W. D.*).
2. *L. TRINERVE* (?), L. & H.
Two-nerved or three-nerved, like *L. trinerve*, L. & H., but narrower. Both the above are parts of *Lepidostrobus*.
U. C., Joggins (*J. W. D.*).
3. *L. MAJUS* (?), Brongn.
M. C., Sydney (*R. Brown*).
4. *LEPIDOPHYLLUM*, sp.
Broad ovate, short, pointed, one-nerved, half an inch long.
U. C., Pictou.
5. *L. INTERMEDIUM*, L. & H.
M. C., Sydney (*R. Brown's list*).
Halonis, *Lepidostrobus* and *Lepidophyllum*, including only parts of *Lepidodendron* and *Lepidophloios*, are to be regarded as merely provisional genera.

LEPIDOPHLOIOS, Sternberg.

1. *LEPIDOPHLOIOS ACADIANUS*, spec. nov. Pl. X. fig. 45, Pl. XI. fig. 51.

Leaf-bases broadly rhombic, or in old stems regularly rhombic, prominent, ascending, terminated by very broad rhombic scars having a central point and two lateral obscure points. Outer bark laminated or scaly. Surface of inner bark with single points or depressions. Leaves long, linear, with a strong keel on one side, 5 inches or more in length. Cone-scars sparsely scattered on thick branches, either in two rows or spirally, both modes being sometimes seen on the same branch. Scalariform axis scarcely an inch in diameter in a stem 5 inches thick. Fruit, an ovate strobile with numerous acute scales covering small globular spore-cases. This species is closely allied to *Ulodendron majus* and *Lepidophloios laricinus*, and presents numerous varieties of marking.

M. C., Joggins, Salmon River, Pictou (*J. W. D.*); Sydney (*R. Brown*).

2. *L. PROMINULUS*, spec. nov. Pl. XI. fig. 52.

Leaf-bases rhombic pyramidal, somewhat wrinkled at the sides, truncated by regularly rhombic scars, each with three approximate vascular points.

M. C., Joggins (*J. W. D.*).

3. *L. PARVUS*, spec. nov. Pl. XI. fig. 50.

Leaf-bases rhombic, small, with rhombic scars broader than long;

vascular points obscure; leaves linear, acute, 3 inches or more in length, with a keel and two faint lateral ribs. Cones large, sessile.

U. C., Pictou; M. C., Joggins (*J. W. D.*); M. C., Sydney (*R. Brown*).

4. *L. PLATYSTIGMA*, spec. nov. Pl. X. figs. 47 & 48.

Leaf-bases rhombic, broader than long, little prominent; scars rhombic, oval, acuminate, slightly emarginate above; vascular points two, approximate or confluent.

M. C., Sydney (*R. Brown*); Joggins (*J. W. D.*).

5. *L. TETRAGONUS*, spec. nov. Pl. X. fig. 49.

Leaf-bases square, furrowed on the sides; leaf-scar central, with apparently a single central vascular point.

M. C., Joggins (*J. W. D.*).

DIPLATEGIUM, Corda.

DIPLATEGIUM RETUSUM, spec. nov. Pl. XIII. fig. 102.

The fragments referable to plants of this genus are imperfect and obscure. The most distinct show leaf-bases ascending obliquely, and terminating by a retuse end with a papilla in the notch. Some less distinct fragments may possibly be imperfectly preserved specimens of *Lepidodendron* or *Lepidophloios*.

M. C., Joggins (*J. W. D.*).

KNORRIA.

Nearly all the plants referred to this genus in the Carboniferous rocks are, as Goeppert has shown, imperfectly preserved stems of *Lepidodendron*. In the Lower Coal-formation many such *Knorria* forms are afforded by *L. corrugatum*.

KNORRIA SELLONII, Sternberg.

This appears different from the ordinary *Knorria*; its supposed leaves may be aerial roots. It has a large pith-cylinder with very distant tabular floors, like *Sternbergia*.

M. C., Sydney (*R. Brown*).

CORDAITES, Unger. (PYCHNOPHYLLUM, Brongn.)

1. CORDAITES BORASSIFOLIA, Corda.

M. C., Pictou (*H. Poole*); Grand Lake (*C. F. Hartt*); Sydney (*R. Brown*); Joggins, Onslow (*J. W. D.*); Bay de Chaleur (*Logan*).

Very abundant in the Middle Coal-formation.

2. *C. SIMPLEX*, spec. nov.

Leaves similar to the last in size and form, but with simple, equal, parallel nerves. It may be a variety, but is characteristic of the Upper Coal-formation.

M. C., Grand River (*C. F. Hartt*); U. C., Pictou (*J. W. D.*).

CARDIOCARPUM, Brongn.

1. *CARDIOCARPUM FLUITANS*, spec. nov. Pl. XII. fig. 74.

Oval; apex entire or notched; surface slightly rugose; nucleus round ovate, acuminate, pitted on the surface, with a raised mesial line.

M. C., Joggins (*J. W. D.*).

2. *C. BISECTUM*, spec. nov. Pl. XII. fig. 73.

Nucleus as in the last species, but striate; margin widely notched at apex, and more narrowly notched below.

M. C., Grand Lake (*C. F. Hartt*).

3. *CARDIOCARPUM*, sp. like *C. marginatum*.

M. C., Joggins (*J. W. D.*).

4. *CARDIOCARPUM*, sp. allied to *C. latum*, Newberry.

M. C., Pictou (*H. Poole*).

These *Cardiocarpa* are excessively abundant in the roofs of some coal-seams; and the typical ones must have been samaras or winged nutlets. They must have belonged to phænogamous plants, and certainly are not the fruits of *Lepidodendron*, though some of the spore-cases of this genus have been described as *Cardiocarpa*. These I propose to place under the provisional genus *Sporangites*.

SPORANGITES, Dawson.

1. *SPORANGITES PAPILLATA*, spec. nov. Pl. XII. fig. 80.

I propose the provisional generic name of *Sporangites* for spores or spore-cases of *Lepidodendron*, *Calamites*, and similar plants, not referred to the species to which they belong. The present species is round, about 1 inch in diameter, and covered with minute raised papillæ or spines. It abounds in the roof of several of the shaly coals in the Joggins section, and especially in one in group 19 of that section.

M. C., Joggins (*J. W. D.*).

2. *S. GLABRA*, spec. nov. Pl. XII. fig. 81.

About the size of a mustard-seed, round and smooth. Exceedingly abundant in the Lower Carboniferous Coal-measures of Horton Bluff, with *Lepidodendron corrugatum*, to which it possibly belongs. A similar spore-case, possibly of another species of *Lepidodendron*, occurs rarely in the Middle Coal-formation at the Joggins.

STERNBERGIA, Artis.

This provisional genus includes the piths of *Dadoxylon*, *Sigillaria*, and other plants, usually preserved as casts in sandstone, retaining more or less perfectly the transverse partitions into which the pith-cylinders of many coal-formation trees became divided in the process of growth. These fossils are most abundant in the Upper Coal-formation, but occur also in the Middle Coal-formation. The following varieties may be distinguished:—

(a) Var. *approximata*, with fine uniform transverse wrinkles. This is usually invested with a thin coating of structureless coal.

(b) Var. *angularis*, with coarser and more angular transverse wrinkles. This is the character of the pith of *Dadoxylon*.

(c) Var. *distans*, usually of small size, and with distant and irregular wrinkles. This is sometimes invested with wood having the structure of *Calamodendron*, and perhaps is not generically distinct from *C. approximatum*.

(d) Var. *obscura*, with distinct and distant transverse wrinkles, but not strongly marked on the surface. This is the character of the pith-cylinders of *Sigillaria* and *Lepidophloios*.

ENDOGENITES, L. & H.

Many sandstone-casts, answering to the character of the plants described under this name by Lindley, occur in the Upper Coal-formation. They are sometimes 3 inches in diameter, and several feet in length, irregularly striated longitudinally, and invested with coaly matter. Sometimes they show transverse striation in parts of their length. I believe they are casts of pith-cylinders of the nature of *Sternbergia*, and probably of Sigillarioid trees.

SOLENTES, L. & H.

Plants of this kind are found in the sandstones of the Upper Coal-formation of the Joggins.

For all the specimens noticed in the above list as collected by Sir W. E. Logan, Richard Brown, Esq., of Sydney, Cape Breton, Henry Poole, Esq., of Glace Bay, C.B., and G. F. and C. B. Matthew and C. F. Hart, Esqs., St. John, New Brunswick, I am indebted to the kindness of those gentlemen. To Mr. Brown especially I am under great obligations for his liberality in placing at my disposal his large and valuable collection of the plants of the Cape Breton coal-field.

EXPLANATION OF PLATES V.-XIII.

Illustrative of the Coal-plants of British North America.

PLATE V.

- Fig. 1. *Dadoxylon antiquius*: longitudinal section, radial, magnified 90 diameters.
2. The same: longitudinal section, tangential, magnified 90 diameters: *a*, medullary rays.
3. The same: portions of cells showing areolation, magnified 250 diameters.
4. *Dadoxylon Acadianum*: longitudinal section, radial, magnified 90 diameters.
5. The same: longitudinal section, tangential, magnified 90 diameters: *a*, medullary rays.
6. The same: portion of cell showing areolations, magnified 250 diameters.
7. *Dadoxylon materiarium*: longitudinal section, radial, magnified 70 diameters.
8. The same: longitudinal section, tangential, magnified 70 diameters: *a*, medullary rays.
9. The same: portion of shell showing areolation, magnified 250 diameters.
10. *D. annulatum*: longitudinal section, radial, magnified 70 diameters.

- Fig. 11. The same: longitudinal section, magnified 90 diameters: *a*, one of the concentric rings of compact coaly matter.
 12. The same: portion of a cell showing areolation, natural size.
 13. The same: transverse section, natural size: *a*, pith; *b*, wood, composed of alternate circles of areolated cells and compact coaly matter; *c*, coaly bark.

PLATE VI.

- Fig. 14. *Araucarites gracilis*: branch with leaves, three-fourths the natural size.
 15. *Sigillaria Brownii*: portion of two ribs, 4 feet above the level, one-half the natural size: *a*, cortical; *b*, decorticated.
 16. The same: portion of one rib near the root, furrowed and with vascular scars widely separated.
 17. The same: trunk 1 foot in diameter at the base, showing the origin of the ribs.
 18. The same: photograph of a portion of the upper part of the stem, one-half the natural size.
 19. The same: portion of the base of the stem, one-half the natural size, from a photograph.
 20. The same: Sigillarian root of this or an allied species.
 21. *Sigillaria planicosta*, from a photograph, one-half the natural size; 21 *a*, scar and part of rib, one-half the natural size.
 22. — *catenoides*, from a photograph, one-half the natural size; 22 *a*, scar and part of ribs, one-half the natural size.
 23. — *striata*: flattened stem, from a photograph, two-thirds the natural size; 23 *a*, part of stem, same size; 23 *b*, scar, enlarged.
 24. — *eminens*: decorticated stem, from a photograph, much reduced; 24 *a*, scar, one-half the natural size.
 25. — *scutellata*, from a photograph, two-thirds the natural size, with band of interrupted growth; 25 *a*, ordinary areole, natural size; 25 *b*, areoles from the regular band, natural size.

PLATE VII.

- Fig. 26. *Sigillaria elegans*: decorticated stem, from a photograph, one-half the natural size, with band of interrupted growth at β ; 26 *a*, corticated and flattened stem, one-half the natural size, with branches at β & γ ; 26 *b*, leaf of *S. elegans*; 26 *c*, areoles of a branch; 26 *d*, areole of main stem.
 27. — *Bretonensis*: corticated stem, from a photograph, two-thirds the natural size; 27 *a*, areole, natural size.
 28. — *Sydnensis*: decorticated stem, from a photograph, two-thirds the natural size; 28 *a*, areoles of decorticated stem; 28 *b* & *c*, variety of Stigmarian root attached to this species.
 29. *Antholithes squamosus*, from a photograph, two-thirds the natural size.
 30. — *Rhabdocarpi*, from a photograph, two-thirds the natural size; 30 *a*, a larger specimen of the same; 30 *b*, single outlet of the same, natural size.
 30 *c*. — *pygmaeus*: fragment, natural size.
 31. *Calamodendron approximatum*, one-half the natural size; 31 *a*, cast of pith; 31 *b*, coaly or woody investment; 31 *c*, tissues of wood of *Calamodendron*, magnified.
 31 *d*. Tissues of a different species of *Calamodendron* or of *Calamites*.

PLATE VIII.

- Fig. 32. Leaflets of *Cyclopteris Acadica*, from a photograph, one-third the natural size; 32 *a*, petiole of the same, one-third natural size; 32 *b*, divisions of petiole, one-half the natural size; 32 *c*, leaflets; 32 *d*, leaflet; 32 *e*, leaflet enlarged, showing venation; 32 *f*, striation of petiole enlarged; 32 *g*, *h*, remains of fructification; 32 *i*, base of petiole, much reduced.
 33. *Megaphyton humile*: β , leaf-scars; γ , part of axis: from a photograph, two-thirds the natural size.

- Fig. 34. *Megaphyton magnificum*: portion of stem, one-sixth the natural size; 34 a, leaf-scar, from a photograph, two-thirds the natural size.
 35. *Palæopteris Hartii*, one-half the natural size.
 36. — *Acadica*, one-half the natural size.

PLATE IX.

- Fig. 37. *Lepidodendron Pictoense*, branchlets and leaves, from a photograph, one-half the natural size (β , cone); 37 a, leafy branch; 37 b, branch with areoles; 37 c, larger branch; 37 d, old stem with deep furrows, and at β areoles, not enlarged; 37 e, leaves. Figs 37 a to 37 e, from photographs two-thirds the natural size. 37 f, areole enlarged; 37 g, leaf enlarged.
 38. — *plicatum*, portion of old stem; 38 a, areole of branch, these areoles being placed in contact on such young branches.
 39. — *personatum*, leafy branch; 39 a, larger stem with areoles; both from photographs, two-thirds the natural size; 39 b, areole, enlarged; 39 c, leaf, natural size.
 40. — *decurtatum*, from a photograph, two-thirds the natural size; 40 a, areole, enlarged.
 41. — *undulatum*, portion of old stem, showing enlarged areoles, furrows, and two cone-scars.
 42, 43. Portions of old stems, probably of *L. rimosum* or allied species.

PLATE X.

- Fig. 44. Portions of old stems, probably of *Lepidodendron rimosum* or an allied species.
 45. *Lepidophloios Acadianus*, stem with marks of cones, from a photograph, one-half the natural size; 45 a, portion of stem with areoles, from a photograph, two-thirds the natural size; 45 b, decorticated stem, natural size; 45 c & d, opposite sides of the same stem, reduced, to show the different arrangement of the cone-scars; 45 e, part of a leaf, natural size; 45 f, g, h, areoles from different parts of stem.
 46. Strobile of *Lepidophloios*; 46 a, transverse section of a similar strobile; from photographs, two-thirds the natural size.
 47 & 48. *Lepidophloios platystigma*, from a photograph, two-thirds the natural size; 47 a & 48 a, areole of the same, natural size.
 49. — *tetragonus*, from photograph, two-thirds the natural size; 49 a, areole, two-thirds the natural size.

PLATE XI.

- Fig. 50. *Lepidophloios parvus*, stem with areoles and scars of cones; 50 a, group of leaves; both from photographs, two-thirds the natural size; 50 b, areole, natural size.
 51. Cross section of *Lepidophloios Acadianus*, showing the outer rind and woody axis, one-tenth the natural size; 51 a, scalariform vessels of axis, magnified; 51 b, transverse section of part of the axis, showing the vascular bundles which proceed to the leaves, and the different diameters of the outer and inner circles of vessels; 51 c, smaller portion of the axis, showing one bundle of vessels.
 52. *Lepidophloios prominulus*, portion of cast, from a photograph, two-thirds the natural size; 52 a, areole, natural size.
 53. *Lepidodendron corrugatum*, young branch with cone; 53 a, branch with leaves; 53 c, older branch with areoles beginning to separate; 53 d, variety with alternate areoles; 53 e, variety with areoles in vertical rows; 53 f, g, old trunks, with widely separated areoles; 53 h, photograph of branch; 53 i, Knorria, or decorticated state; 53 k, fragment, showing ramification; 53 l, bark with areoles in transverse rows; 53 m, spore-case, natural size and magnified; 53 n to r, areoles in various states; 53 s, leaf, enlarged.
 54. Scalariform vessel of *Lepidodendron*.
 55. " " *Stigmaria*.

PLATE XII.

Fig. 56. Scalariform vessel of *Lepidophloios*.

57. Tissues of *Sigillaria*.

58. Vessel of *Sphenophyllum*.

59. Tissues of *Calamodendron*.

60. Tissues of *Calamites*.

61. Scalariform tissue of Ferns.

62. Bast tissue of *Sigillaria*.

63. Cells of *Dadoxylon Acadianum*.

64. Cells of *D. materiarium*.

65. Cuticle of *Pinnularia*.

66. Vessel of *Sphenophyllum*, 200 diameters.

67. Vessels and cells from vascular bundles of Ferns, 200 diameters.

68. Tissues of *Sigillaria*, 200 diameters.

69. *Rhabdocarpus insignis*.

70-72. *Cardiocarpum*, spp.

73. *C. bisectum*.

74. *C. fluitans*.

75. *Trigonocarpum minus*.

76. *T. Sigillarie*.

77. *T. avellanum*.

78. *T. intermedium*; 78 a, nucleus of do.

79. *T. Næggerathi*.

80. *Sporangites papillata*; 80 b, nat. size.

81. *S. glabra*; 81 b, nat. size.

82. Fragment of *Antholithes*.

83. Stigmaria with scars in rhombic areoles.

84. Stigmaria with bark divided by vertical furrows (var. *alternans*).

85. Stigmaria with large scars in elongated areoles.

86. Stigmaria with elongated scars (*Knorria* form).

87. Stigmaria another variety, resembling *Diplotegium*.

88. *Equisetites curtus*.

89. *Calamites Nova-scoticus*.

Figs. 54-64 inclusive are drawn to a uniform scale of 90 diameters. Figs. 83 to 87 are taken from photographs, and are two-thirds the natural size.

PLATE XIII.

Fig. 90. *Asterophyllites trinervis*; 90 a, portion of leaf enlarged.

91. *Næggerathia dispar*, one-half natural size.

92. *Cyclopteris hispida*; 92 a, portion of pinnule magnified, showing hairy surface and impressions of nervures.

93. *Neuropteris perelegans*; a, portion magnified, showing venation.

94. — *cyclopteroides*.

95. *Cyclopteris antiqua*.

96. *Phyllopteris antiqua*; 96 a, portion magnified, showing venation.

97. *Sphenopteris munda*; 97 a, portion magnified.

98. — *latior*; 98 a, pinnule magnified, showing venation and sori.

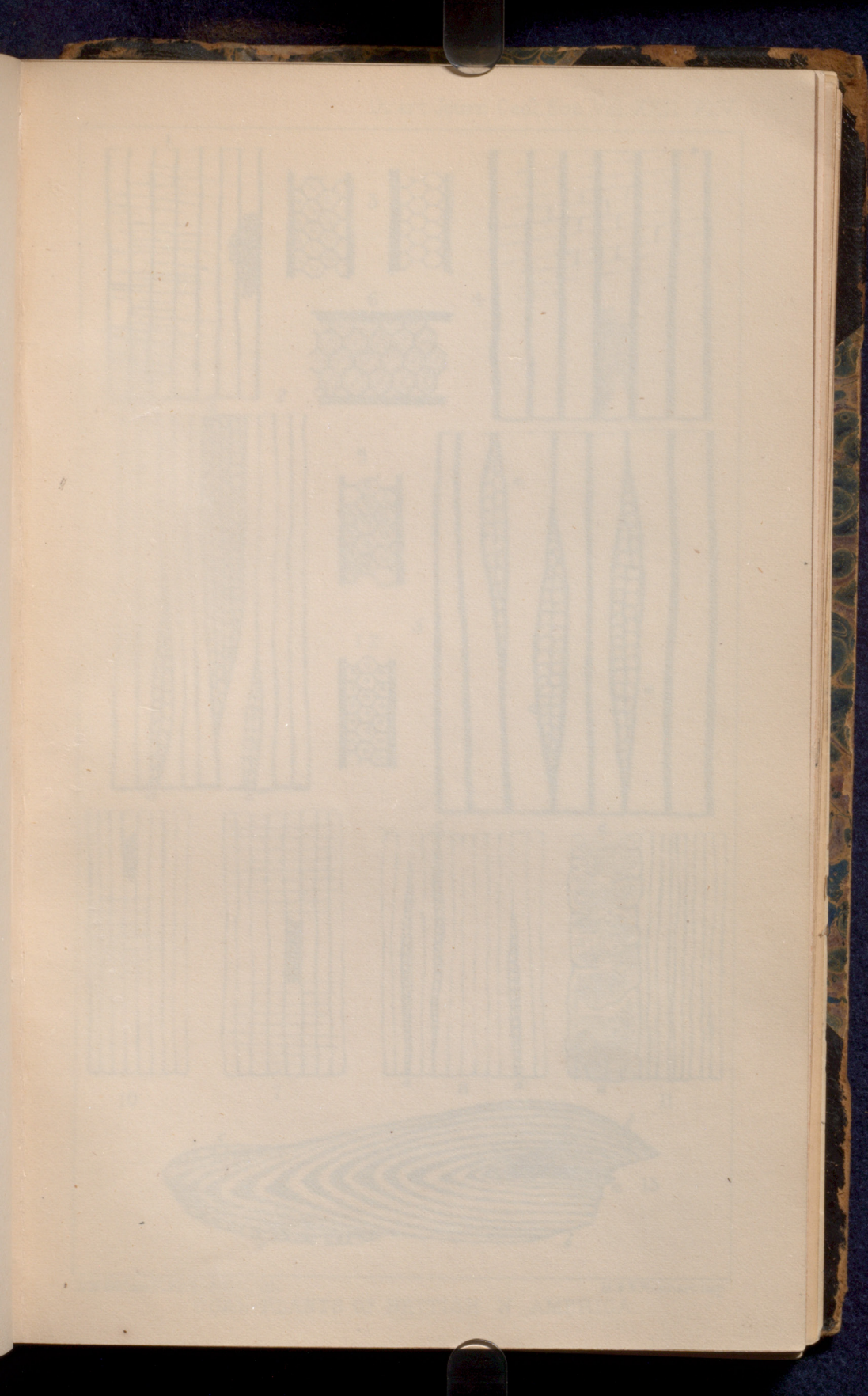
99. — *Canadensis*; 99 a, pinnule magnified, showing venation.

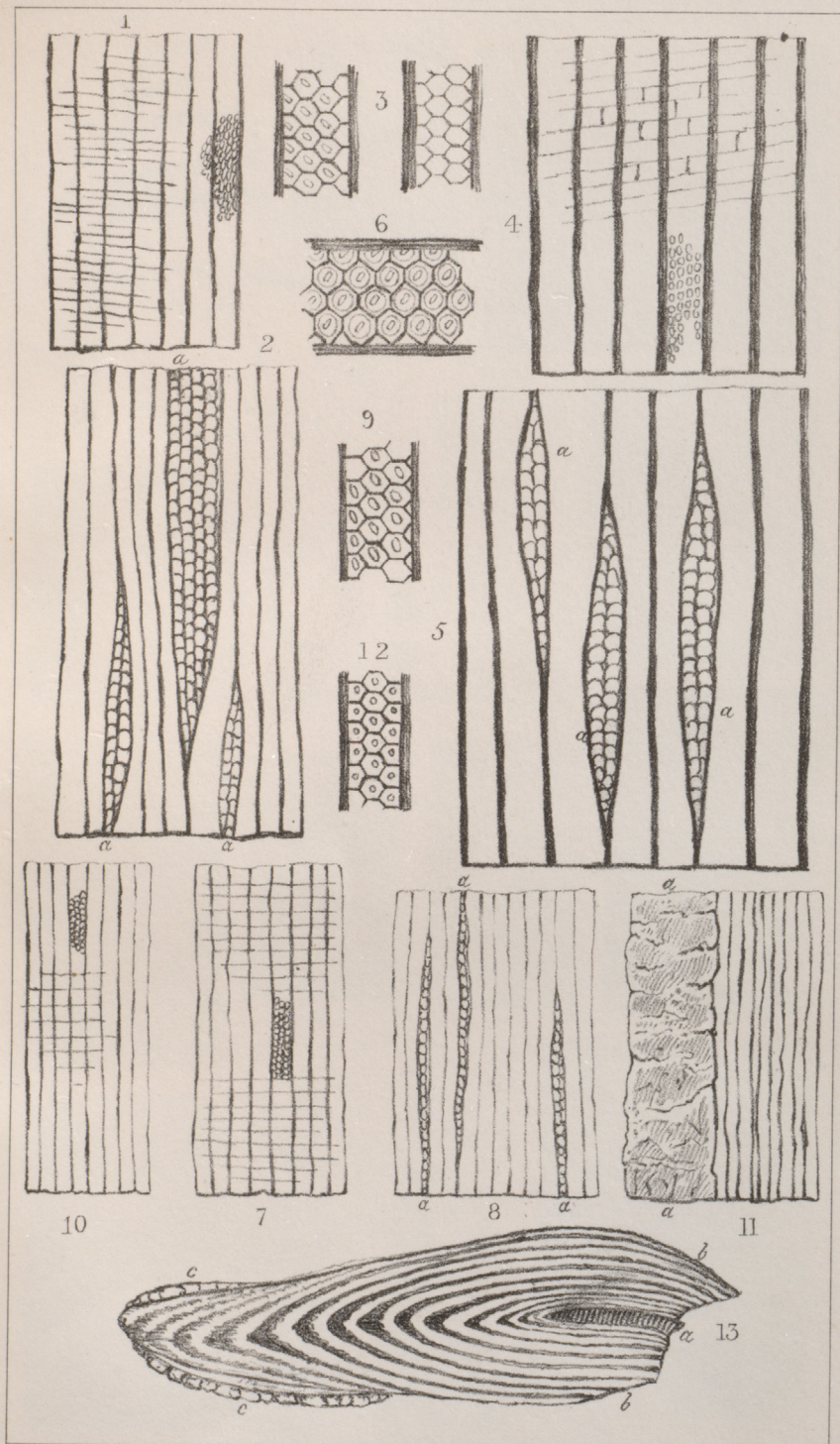
100 and 100 a & b. Pinnules of *Alethopteris grandis*; 100 a, portion magnified, showing venation.

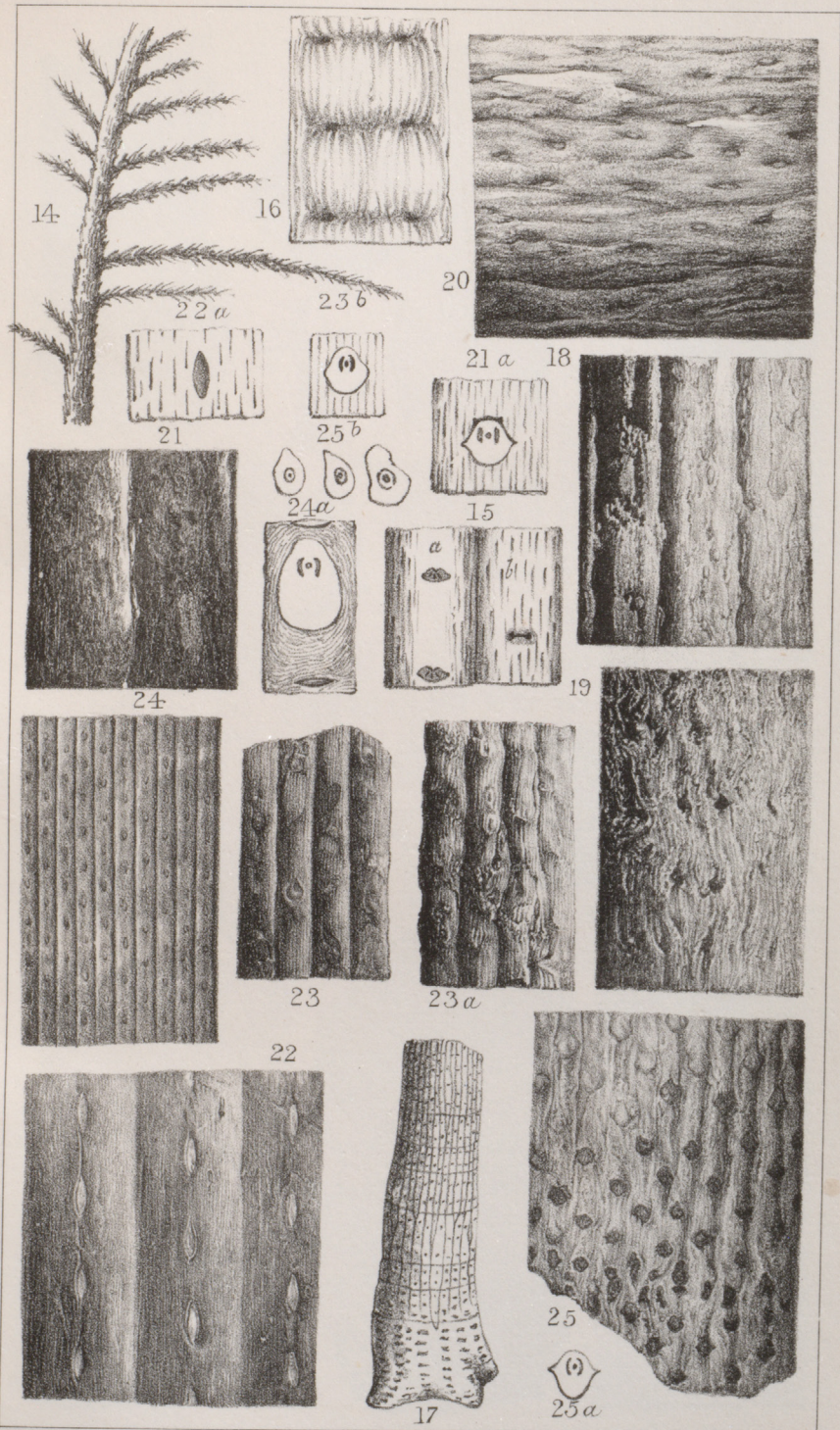
101. *Beinertia Goeperti*; 101 a, pinnule magnified, showing venation.

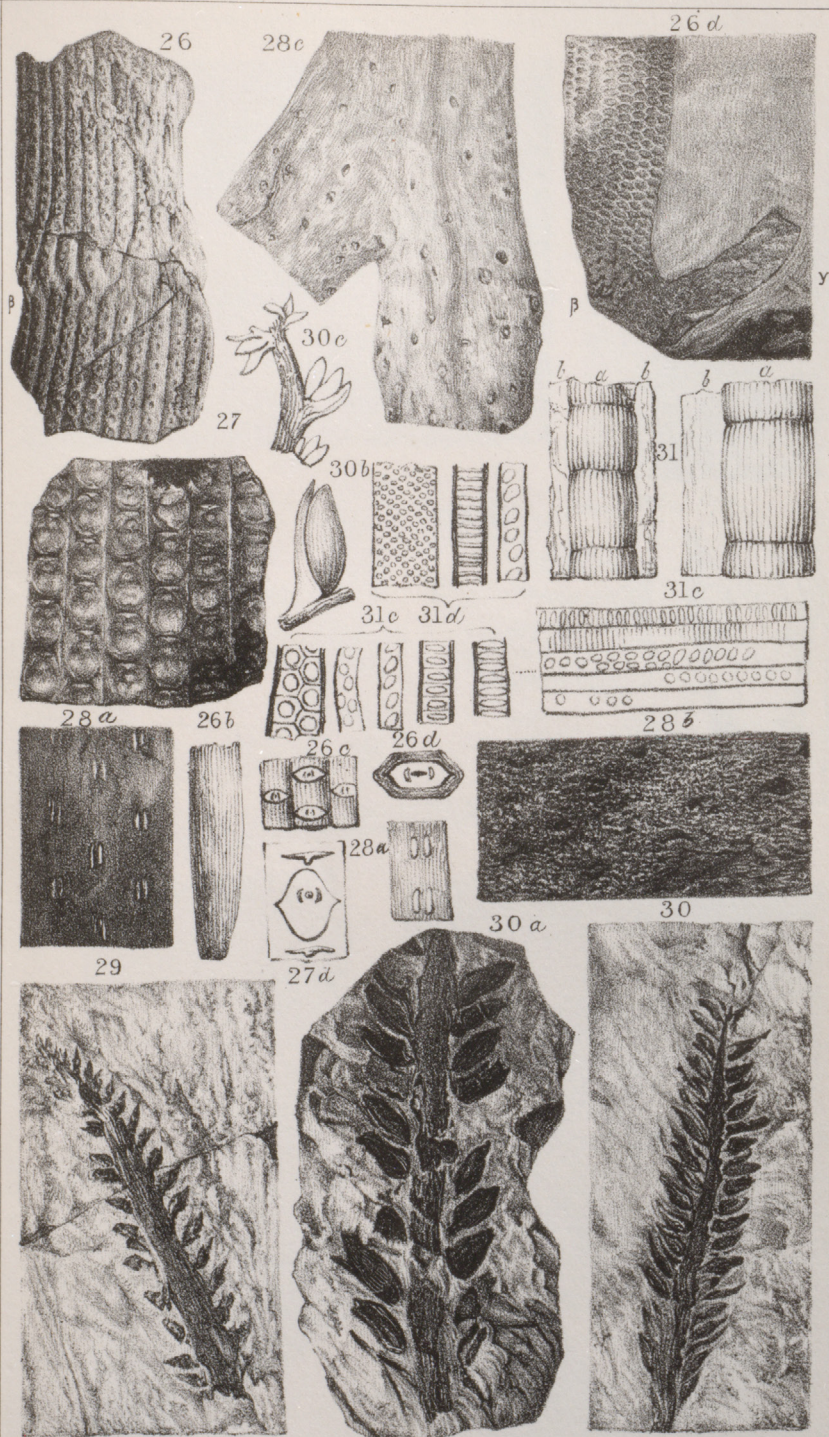
102. *Diplotegium retusum*; 102 a, leaf-scar magnified.

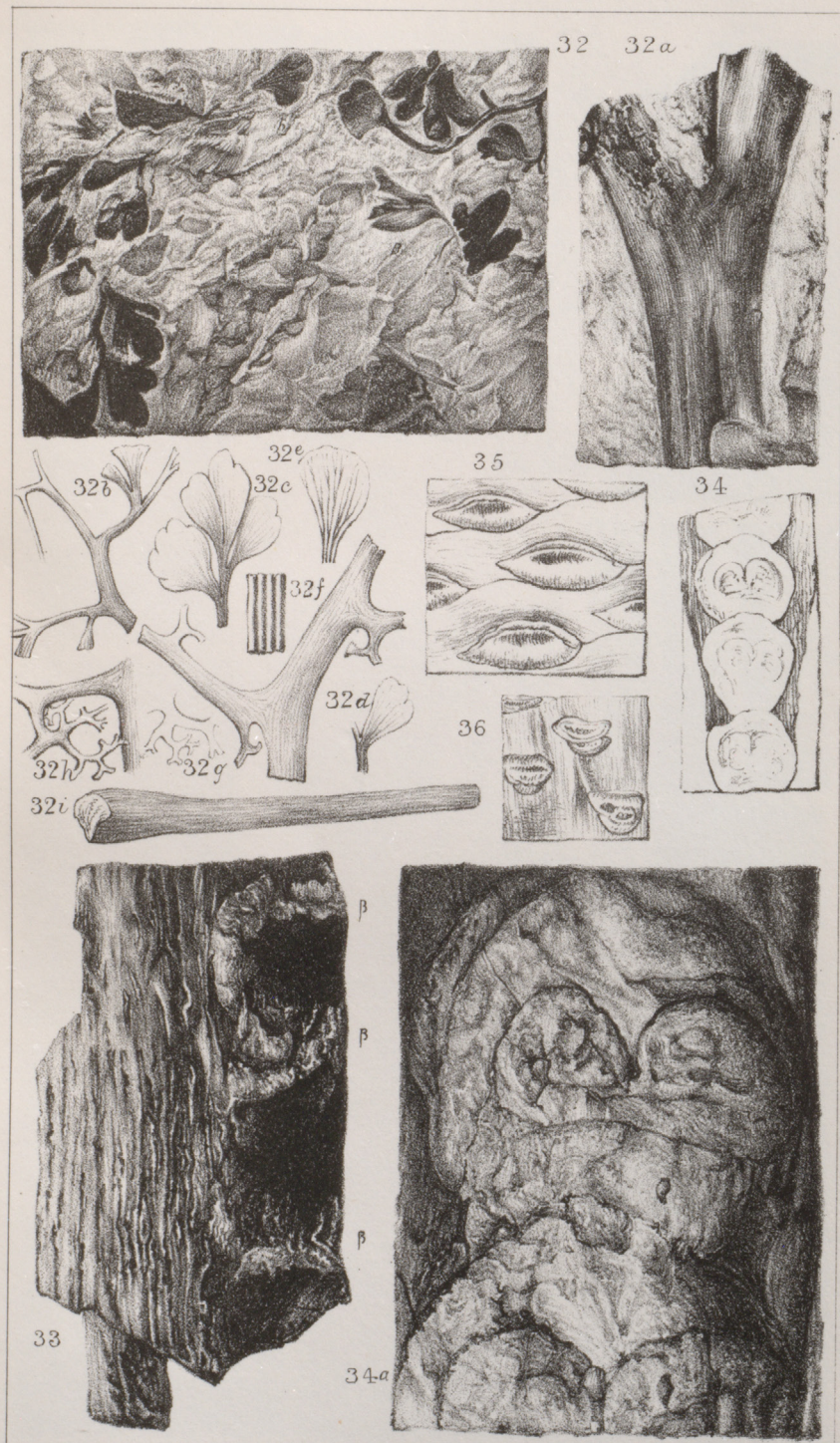
103. *Lonchopteris tenuis*; 103 a, portion enlarged, showing character of surface.





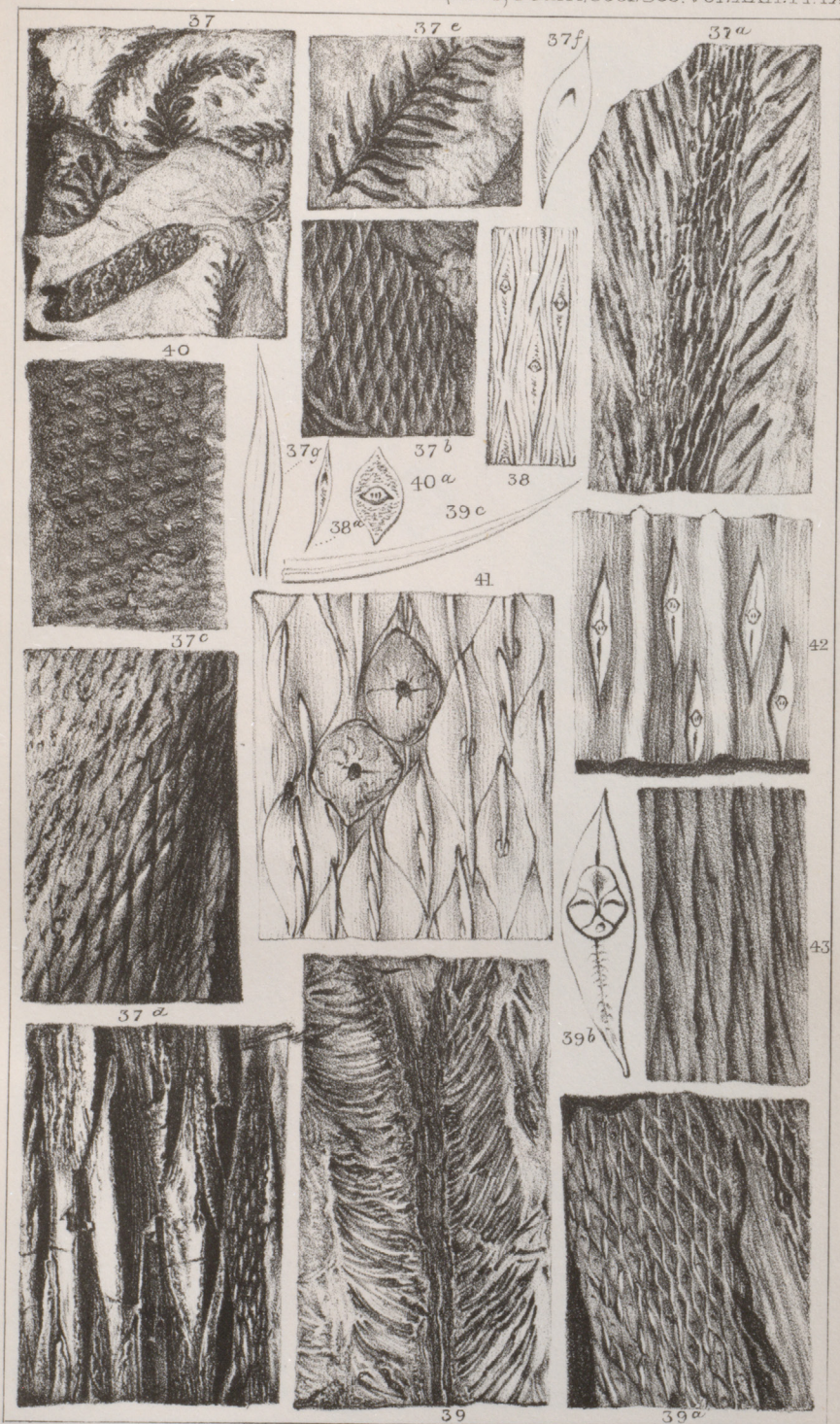






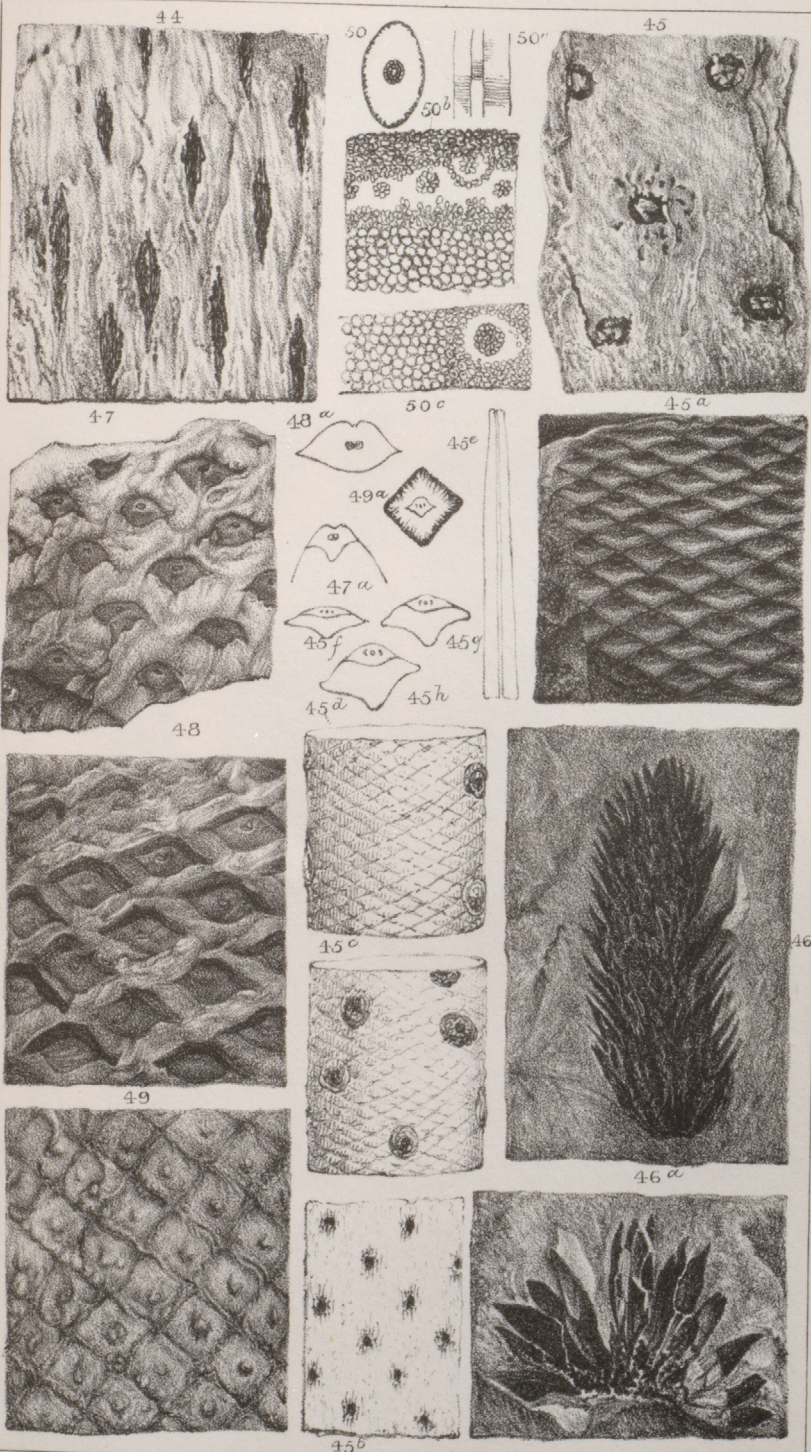
E. M. Williams F.L.S. F.Z.S. lith.

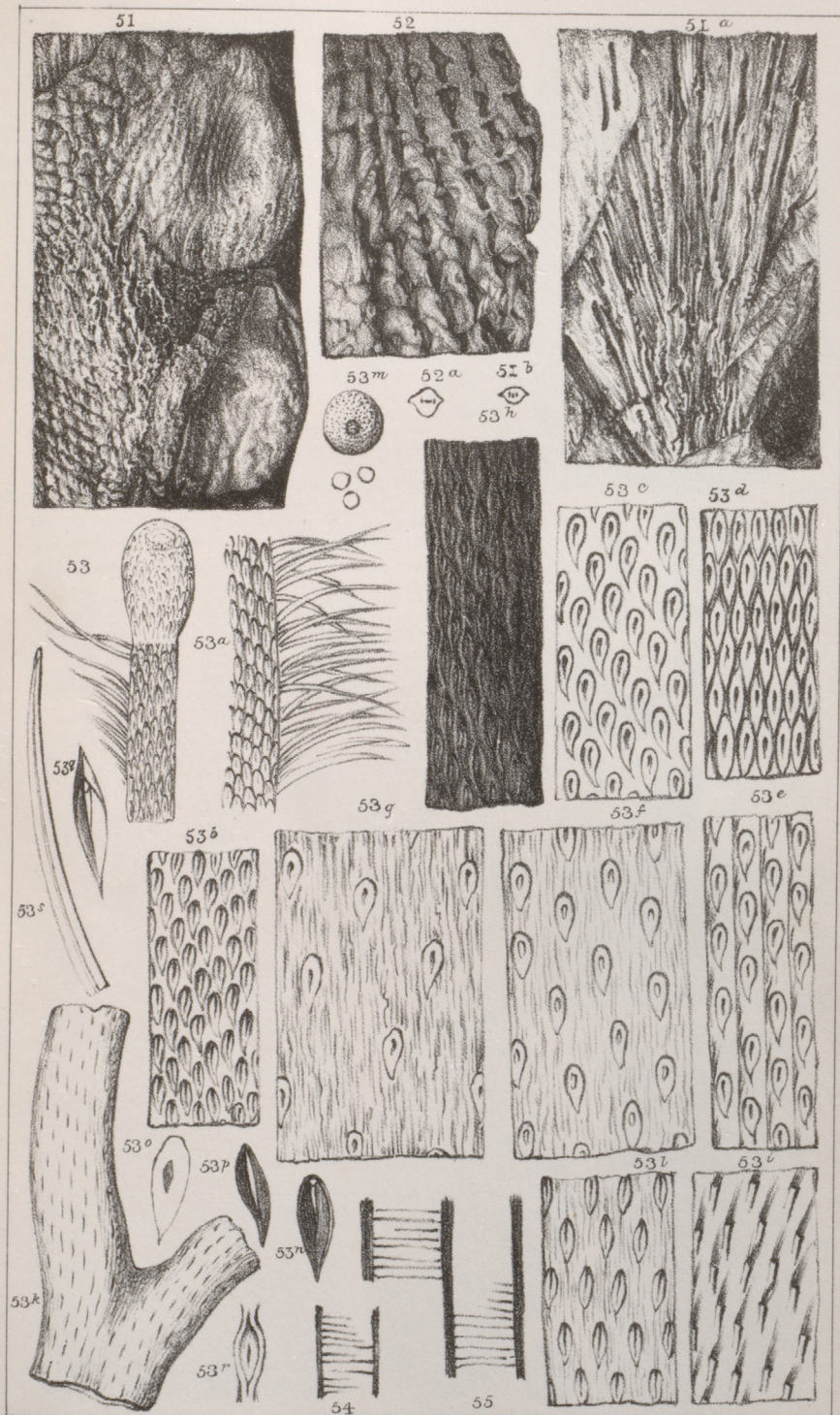
M. & N. Hanhart imp.



E.M. Williams FLS. F.Z.S. lith.

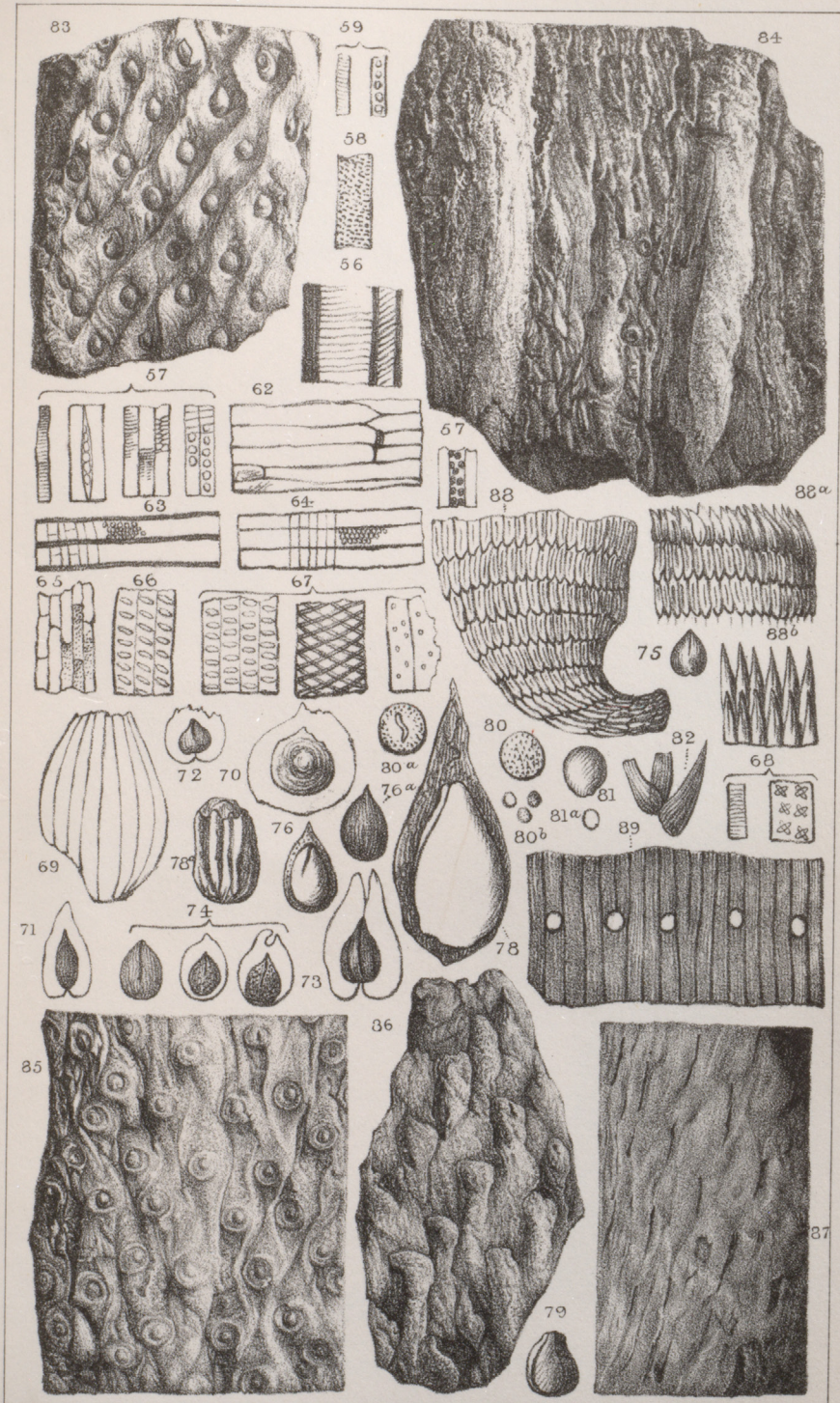
M. & N. Hanhart, imp.





E.M. Williams FLS F.Z.S. lith.

M&N Hanhart imp.



EM Williams FLS.F.Z.S.lith

M&N Hanhart imp



EM Williams FLS FZ Shh.

M & N Earhart imp.

Dr Dawson
with the kind regards of
the Author

ON

THE ORGANIZATION

OF

VOLKMANNIA DAWSONI.

- III. *On the Organization of Volkmannia Dawsoni, an undescribed Verticillate Strobilus from the Lower Coal-measures of Lancashire.* By W. C. WILLIAMSON, F.R.S., Professor of Natural History in Owens College, Manchester.

Read February 7th, 1871.

IN his "Observations on the Structure of Fossil Plants found in the Carboniferous Strata," Mr. Binney has figured three types of verticillate spikes of cryptogamic fructification, which in all probability represent three very different groups of plants. In plates 4 and 5 he has given the structure of one of these types under the name of *Calamodendron commune*. The same type has received from Mr. Carruthers the name of *Volkmannia Binnei* (Journal of Botany, Dec. 1867), whilst Prof. Schimper has designated it *Calamostachys Binneyana*. At the last Meeting of the British Association at Liverpool, I advanced my reasons for believing that this spike had no relationship with the group of Calamites; and the same view is advanced in a still more recent "Memoir on the Organization of Calamites," presented to the Royal Society. In the type referred to, as is well known, the several nodes of the central axis give off bractigerous disks and sporangio-phores in alternate verticils. In his plate vi., Mr. Binney figures a spike (fig. 1), in which the sporangia are very compactly clustered in verticils, which are very closely embraced by a bractigerous disk springing from each node. I believe this figure represents the same plant as that of which I recently described the internal organization ("On a new form of Calamitean Strobilus from the Lancashire Coal-measures," Memoirs of the Literary and

Philosophical Society of Manchester, Third Series, vol. iv. p. 248) ; and I have not the slightest doubt that it represents a true Calamitean fructification. The reasons for this firm conviction are given in the memoir referred to.

But Mr. Binney also figures a third form (tab. vi. fig. 4), in which the spikes have a much more lax habit. The bracts fringing the bractigerous disk do not embrace the sporangia, but project from beneath them in a rigid manner, leaving the sporangia, loosely located between each verticillate bractigerous disk, conspicuously exposed to view. The same type of fructification has recently been found in carboniferous shales exposed in a railway-cutting at Huyton, near Liverpool, by the Rev. H. Higgins.

In a second, brief memoir ("On the Organs of Fructification and Foliage of *Calamodendron commune* (?)", Memoirs of the Literary and Philosophical Society of Manchester, Third Series, vol. iv. p. 218), Mr. Binney has figured a second specimen of what I believe to be the true Calamitean type of fruit.

Mr. Butterworth placed in my hands some months ago a small strobilus which he had found in the Lower Coal-measures near Oldham ; and on investigating its organization I soon found that it belonged to the third of the three types to which I have directed attention, viz. that with rigid bracts and exposed sporangia. Its internal structure demonstrates that it is altogether different from either of the other two types referred to, and evidently belongs to a different plant. A fragment of the fruit, which we have retained unsliced, demonstrates its close resemblance to Mr. Binney's tab. vi. fig. 4.

The spike or strobilus now to be described consists of a central axis, sustaining successive concavo-convex disks, which divide at their peripheral margins into a considerable number of long, stiff, slightly curved bracts. Between each of these bractigerous disks is a single layer of spo-

rangia, arranged in about four irregular circles. Each sporangium appears to have its own sporangiphore, of which considerable numbers spring from the upper surface of each disk.

The Axis.—This resolves itself into a central vascular mass (*a*) lodged in what is now a clear space (*c*), but which was at one time doubtless occupied by cellular tissue, the greater part of which has disappeared, either by absorption or decay. This space is surrounded by a cellular cylinder (*b*) consisting chiefly of a dense form of prosenchyma, and of which the bractigerous disks are extensions. The form assumed by the central vascular axis (*a*) constitutes one of the most characteristic features of the organism. Its transverse section (fig. 5) may be described as a triangle with concave sides (*a* 1) and concavely truncated angles (*a* 2). It consists of a mass of vessels, which are largest in the central portions, and smallest and most dense at the periphery, especially at the angles (*a* 2). At each of the latter portions the structure becomes broader, in consequence of the projection of two lateral vascular extensions (*a* 4) than it is nearer the centre. From each of these projections a line of compressed and disorganized cellular tissue (*a* 3) extends like a chord across the arc described by the concave side of the triangle, and at *a* 5 we see a similar band stretching across the concavely truncated angle. At *a'* 3 and *a'* 5 we see clear proof that these have originally been layers of cellular tissue that have closely invested the vascular axis, but which have become detached and shortened during some of the morphological changes which the plant has undergone. Most probably this axis originally occupied the centre of the open cylindrical space *c*, but has been drawn to one side, on the disappearance of the cellular tissue surrounding it. Fig. 5 *b* represents a portion of the outer or prosenchymatous cylinder of the axis. In the longitudinal section, fig. 1,

we see that this central axis consists of vessels ; but I am unable to discover in them any trace either of transverse bars or of reticulations. This, however, is in all probability due to the peculiar state of mineralization which the entire specimen exhibits. The general *outlines* are everywhere exquisitely preserved ; but the minute texture, both of cells and vessels, is so altered that no reliance can be placed upon its indications. That the vessels have been thickened by internal deposits of some kind is clear enough. The greater diameter of the vascular axis between its most distant angles is $\cdot 065$. That of the largest of its component vessels is about $\cdot 0037$ of an inch. Of the tissues originally occupying the space (*c*) between the axis just described and the outer prosenchymatous cylinder (*b*), we have little or no indication, a few shreds of what may have been cellular tissue being the only remains of them.

In describing the prosenchymatous cylinder (*b*), we have to distinguish between its several parts. It gives off the bractigerous disks ; or perhaps it may be more correctly defined as consisting of the central portion of each disk, prolonged downward to the node below, as shown in figures 1 and 2. It of course follows that its prosenchymatous walls are thinnest in a transverse section made immediately above each disk (fig. 4 *b*), and thickest at the points where the disk springs from it (fig. 4 *b'*). The prosenchymatous structure of its walls is shown at fig. 2 *b'*, where a tangential section has intersected the cells in the plane of their longer axes. The mean length of these cells is very variable, their diameter about $\cdot 0024$ of an inch. The diameter of the exterior of the cylinder at its narrowest part, just above a node, is $\cdot 13$. At each node the cylinder just described gives off a thick bractigerous disk (*d*), which extends upwards and outwards, at an angle of about 45° , curving slightly upwards and inwards as it ascends. It extends about the eighth of

an inch from the inner surface of the prosenchymatous cylinder, in an undivided manner; but its tendency to break up into subdivisions is seen in the crenulated outline *e*, in the sections figs. 3 and 4. This crenulation is the result of deep radiating grooves indenting the inferior surface of the disk. These deepen as they proceed outwards, and soon divide the disk into a verticil of separated bracts. In fig. 4 we see the first result of this division in the series of irregular masses (*f f*); but the true form of these divisions is masked in the part referred to, because the section has passed through them very obliquely, in fact almost in the plane of their two surfaces. The form and appearance of true sections are better seen at *f''* in the same figure. But their relative positions will be still better understood by referring to fig. 6, which represents a tangential section made vertically through three of the bractigerous disks, a little externally to the point at which that structure is divided into its peripheral fringe of elongated bracts. Sections of these bracts are seen at *f'*, whilst at the side of the cone, *f''*, these bracts extend upwards to their termination in the plane of the section. In the latter portions we see that their two epidermal surfaces appear to have been more dense and solid than their central portions. On turning to tranverse sections of these uppermost portions of the bracts, as we see them at *f'' f''* in figures 3 and 4, we discover that they here become more depressed, thinner, and more leaf-like than they are at *f'*. At the latter point they are separated from each other by distinct intervals, and even at their extremities they have not approached sufficiently entirely to hide the sporangia from view. At their bases these bracts have a breadth of from .035 to .04 of an inch.

The vertical sections, figs. 1 and 2, show the thick and succulent character of the disk, and the gradual thinning of the bracteated subdivisions *f*. The appearance of

the prosenchymatous cells composing the bractigerous disk and the lower portions of the bracts is shown in fig. 7.

The Sporangia.—These are arranged, nearly in a single plane, in the concavo-convex space between each two contiguous bractigerous disks, and appear to be grouped in from three to four irregular concentric circles within each space. Each sporangium has a mean diameter of about $\cdot 06$. The sporangium-wall (*g*) is dense, thick, and cellular; but defective mineralization prevents my ascertaining the exact arrangement of its cells. I have already pointed out that the sporangiophores are so numerous as to suggest the probability that there is a separate one for each sporangium. They arise entirely from the bractigerous disk, and not from the bracts. In fig. 2 we have, at *h*, a tangential section crossing one of these disks; and its upper surface is seen to be crenulated with the intersected bases of these sporangiophores. They are also seen in great numbers, sometimes intersected longitudinally, but more frequently transversely, at *h h* in the sections 3 and 4. Their mean diameter is about $\cdot 0075$. Fig. 7 represents the base of one of these sporangiophores, seen near the base of the lower right-hand bract of fig. 2 *f''*, but more highly magnified; and fig. 8 exhibits a transverse section of one of them still more enlarged. Both these sections demonstrate their cellular character. They may possibly have contained a few vessels; but I have not succeeded in detecting them. Since these organs all spring from the bractigerous disks, those sustaining the outermost series of sporangia must have required to be much elongated. Figs. 2 *h* and 4 *h'* demonstrate that such is the case. Their transverse section (fig. 8) is usually a circular one. In the tangential section (fig. 6) we discover a row of intersected sporangiophores, *h*, immediately above each disk, and below the sporangia. Fig. 2 *h* further explains this arrangement.

They evidently crept along the upper surface of the disk, as is the case amongst ferns.

In nearly every instance each sporangium is occupied by a cluster of beautiful spores. The appearances which these objects present vary according to the direction of their section, as is well represented in fig. 9. At the first glance, we should be tempted to infer that their exteriors had been spinous; but I have not been able to satisfy myself that such has been the case. I rather conclude that the appearance in question is merely the result of defective mineralization, because, as I have already shown, the outlines of all the more delicate cellular tissues of the specimens are similarly masked by irregular protuberances. The mean diameter of these spores is about $\cdot 0037$, or nearly the same size as those of the Calamitean strobilus of which I laid a description before this Society last year.

The preceding description will have demonstrated that this fruit is very different from any of which the internal organization has hitherto been described. The differences are not merely of detail, but of type. The question remaining to be answered is an obvious one, viz. to what plant does this fruit belong? The verticillate arrangement of its bractigerous disks and bracts suggests the probability that we must seek for the parent plant amongst such as have their foliage arranged in corresponding verticils; and if this law of association be a sound one, we are apparently shut up to the three genera, *Asterophyllites*, *Annularia*, and *Sphenophyllum*.

But the separation of the first and the second of these genera is of doubtful propriety; at all events I have not yet succeeded in discovering any definite character by which the two can be distinguished. That plants of the Annularian type constituted the delicate aerial foliage of Calamites, appears to be established by so many independent observations as to leave little room for doubting

the conclusion. It does not follow from this, however, that *all* the Asterophyllites and *Annulariæ* are Calamitean. It is possible that, as Dr. Dawson contends, there may be amongst these verticillate types of foliage one group belonging to Calamites and another to some other class of plants more nearly allied to the Ferns. If this latter possibility be converted by further discoveries into an unquestioned fact, we shall have *two* groups of verticillate-foliaged plants amongst which to find those of which our strobili are the fruits, viz. a section of the Asterophyllites and the genus *Sphenophyllum*.

When we compare the internal organization of the fruits themselves, we discover that we now possess three very distinct kinds, but two of them may, notwithstanding generic differences, belong to allied types, if not to the same.

In the fruit which I previously described, and to which reference was made at the beginning of this memoir, the structure of the central axis is almost exactly that of a Calamitean stem, even in its minuter details. In each there is a central cavity lined with cellular tissue and surrounded by a woody zone consisting of a ring of woody wedges, each of which has a longitudinal canal at its inner border; and this zone, in turn, is invested by a second cellular layer which in the true stem becomes a well-defined bark or dermal layer, but which in the axis of the fruit is not capable of being distinguished, the three tissues being there more intimately blended into one than in the stem. The great point upon which I wish to insist is, that the arrangement of these tissues in the axis of the fruit referred to and in the Calamitean stems is so identical, that no reason whatever can be shown why the former should not have been the terminal prolongation of one of the latter.

But when we come to the other two types, viz. that which both Mr. Binney and Mr. Carruthers have identified

with the Calamites and that which I have now described, the case is altogether different. In both these the vascular tissues of the axis occupy the exact centre of the stem, or what would have been the centre of the fistulo-medullary cavity of a Calamite, whilst all their cellular layers are *external* to the vessels. Now, whilst this is an arrangement common enough amongst some Ferns, and still more so amongst the Lycopodiaceæ, *nothing approaching it* has been seen, either amongst the fossil Calamites or amongst the recent Equisetaceæ, with which some of our phytologists are so anxious to identify the Calamites. Mr. Carruthers very correctly acknowledges that "the axis of the strobilus has a bundle of fine scalariform tissue in its centre, forming about a third of its diameter, and generally appearing free from the surrounding cellular tissue, which is composed of somewhat elongated cells." ("On the Structure of the Fruit of Calamites," by Wm. Carruthers, Esq., F.L.S., Journal of Botany, Dec. 1867.)

Now I cannot conceive the possibility of so complete a reversal taking place in the relative positions of the cellular and vascular tissues of the axis as must have occurred if these fruits ever grew upon a Calamitean stem.

In the case of the plant which I have just described, there is no room for doubting that its foliage was arranged in verticils. Mr. Binney's specimens, especially that represented in his pl. vi. fig. 4, are unmistakably associated with the leaves of *Asterophyllites*; and identical specimens in my own cabinet, apparently belonging to the same type as Mr. Binney's, are similarly associated. It must be remembered also that both Sternberg and Schimper have figured very similar fruits, attached to specimens of the closely allied genus *Sphenophyllum*. Hence it is clear that, if my plant is of the same type as some of those just referred to (and that such is the case there can be no question), we have but a limited range within which to

search for its true affinities. It is the fruit either of *Asterophyllites* or of *Sphenophyllum*; and, judging from the general aspect of its bractigerous disks, I am more disposed to identify it with the former than with the latter. But the important question now returns to us, What are those verticillate plants which are not Calamitean? The first obvious fact is, that they possessed jointed stems. In branched specimens of fructification in my cabinet, the articulations of the central axis are very distinct, and about an inch apart. The stems are flattened by pressure, and exhibit slight indications of longitudinal ridges and furrows, the origin of which I am unable to explain. They are less regular and definite than those of Calamites. The central axis of one of my examples of fruits is six inches in length, giving off six verticils of spikes or strobili, each of which is nearly two inches long; and as I have every reason for supposing that this specimen is only a portion of the original structure, it seems more than probable that the living axis, with its verticillate fructification, may have approached a foot in length. The bractigerous verticils of each strobilus are about the eighth of an inch apart, which is rather more than in our specimen now described; besides which, the latter is broader than the specimens from the shales, so that its spikes have been more compact than in these examples.

The verticillate arrangement of the leaves, and the articulated character of the stems, forbid our associating these plants either with Ferns or with Lycopodiaceæ. On the other hand, the internal organization described in this memoir shows how different they have been from the true Calamites. Yet the two features just referred to obviously indicate closer affinities with the latter genus than with any other of the Carboniferous genera. I have arrived at the conclusion that these plants constituted a distinct family of Asterophyllitaceæ, whose place is near the Cala-

mitaceæ, but occupying a position between the latter group and the Lycopodiaceæ, as indicated by the organization of the central axis, which, as we have seen, is eminently Lycopodiaceous. This conclusion as to the botanical position of these objects has been arrived at from the study of the examples in my own cabinet; but I am glad to find that my friend M. Grand'Eury, of St. Etienne, in France, has arrived at a similar conclusion from the study of specimens found in his own neighbourhood. He ends his reasonings on the subject by affirming, "On peut donc en conclure que les Astérophyllites arborescentes sont issues, non des Calamites, mais des tiges foliifères organisées comme elles" ("Observations sur les Calamites et les Astérophyllites, par M. Grand'Eury." *Comptes Rendus*, tom. lxxviii.). One point of difference between these two types upon which M. Grand'Eury relies has, I think, no existence. He says that the Asterophyllites have "leurs feuilles attachées *au-dessus* des lignes d'articulation et, ce qui est bien autrement significatif, leurs rameaux secondaires insérés à l'aisselle des verticilles foliaires, et non *au-dessous*, ce qui aurait lieu s'ils avaient l'organisation des vraies Calamites" (*loc. cit.*). These supposed differences, as I have shown in a memoir recently laid before the Royal Society of London, do not exist.

I think we may conclude that, of the three types of *Volkmania* of which we know the organization, two are now collocated with their respective stems with a fair degree of probability. There yet remains the *Volkmania Binneyi* demanding a parent axis upon which it can hang. This latter strobilus and the primary subject of this memoir obviously belong to two distinct genera of plants. The former has its sporangiophores arranged in verticils of stiff processes, projecting from each alternate node, and at right angles to the axis, the intermediate nodes giving off

bractigerous disks, whose functions are merely protective. The latter gives off a bractigerous disk from each node, as is also the case with my previously described Calamitean strobilus; but the relations which the sporangiophores bear to the sporangia are very different in the example under consideration from what obtains in either of these other cases. The sporangiophores spring in great numbers from the entire upper surface of the bractigerous disk, though not from its peripheral bracts, the sporangia themselves being loosely aggregated; in the Calamitean type each sporangiophore ascending from the bractigerous disk sustained three or four sporangia closely clustered around it, the entire mass of the fruit being rendered very compact through the intense mutual pressure of its sporangia.

Two fruits so different in the details of their structure as *Volkmannia Binneyi* and the subject of this memoir must, as I have already observed, belong to distinct genera; consequently it is desirable to separate them. This can readily be done by accepting Professor Schimper's generic name, calling the one fruit *Calamostachys Binneyana*, and retaining the other, for the present, in the provisional genus *Volkmannia*. But as the specific features of the latter are very distinctive, and as I cannot identify it *specifically* with those forms of which the external aspect alone has been so often described, I propose to distinguish it by the name of *Volkmannia Dawsoni*, associating with it the name of the eminent geologist who has contributed so much to our knowledge of Canadian palæophytology.

I may observe in conclusion that, though *Calamostachys Binneyana* exhibits features which mark strongly the generic differences between it and *Volkmannia Dawsoni*, the organization of its central axis brings it much nearer to the latter plant than to the Calamites, with which Mr. Carruthers and others have associated it.

INDEX TO PLATES I., II., and III.

(VOLKMANNIA DAWSONI.)

- a.* Central vascular bundle of the axis.
- b.* Outer cellular wall of the axis.
- c.* Middle tissue of the axis, probably cellular.
- d.* Verticillate bractigerous disks.
- e.* Sulcated inferior surface of the peripheral part of the bractigerous disk, indicating its approaching division into succulent bracts.
- f.* Thick primary bracts, resulting from the division of the bractigerous disks.
- f'.* Middle portion of the bracts, where they exhibit an oval transverse section.
- f''.* Extremities of the depressed bracts, exhibiting an oblong linear transverse section.
- g.* Walls of the sporangia.
- h.* Sporangioophores.
- x x* (fig. 1). Line of the transverse section fig. 3.
- y y*. Line of the transverse section fig. 4, only from a part of the strobilus on the right hand, where sufficiently perfect to cross the line of section.
- z z*. Line of the tangential section fig. 6.

Pl. II.

- Fig. 1. Vertical section through the centre of the axis.
- 2. Oblique tangential section, crossing the bractigerous disk at its upper part, and passing between the outer cellular cylinder of the axis and its central vessels inferiorly.

Pl. I.

- Fig. 3. Slightly oblique transverse section, made in the plane of the line *x x* of fig. 1.
- 4. Similar section, made in the plane of the line *y y*, fig. 1.

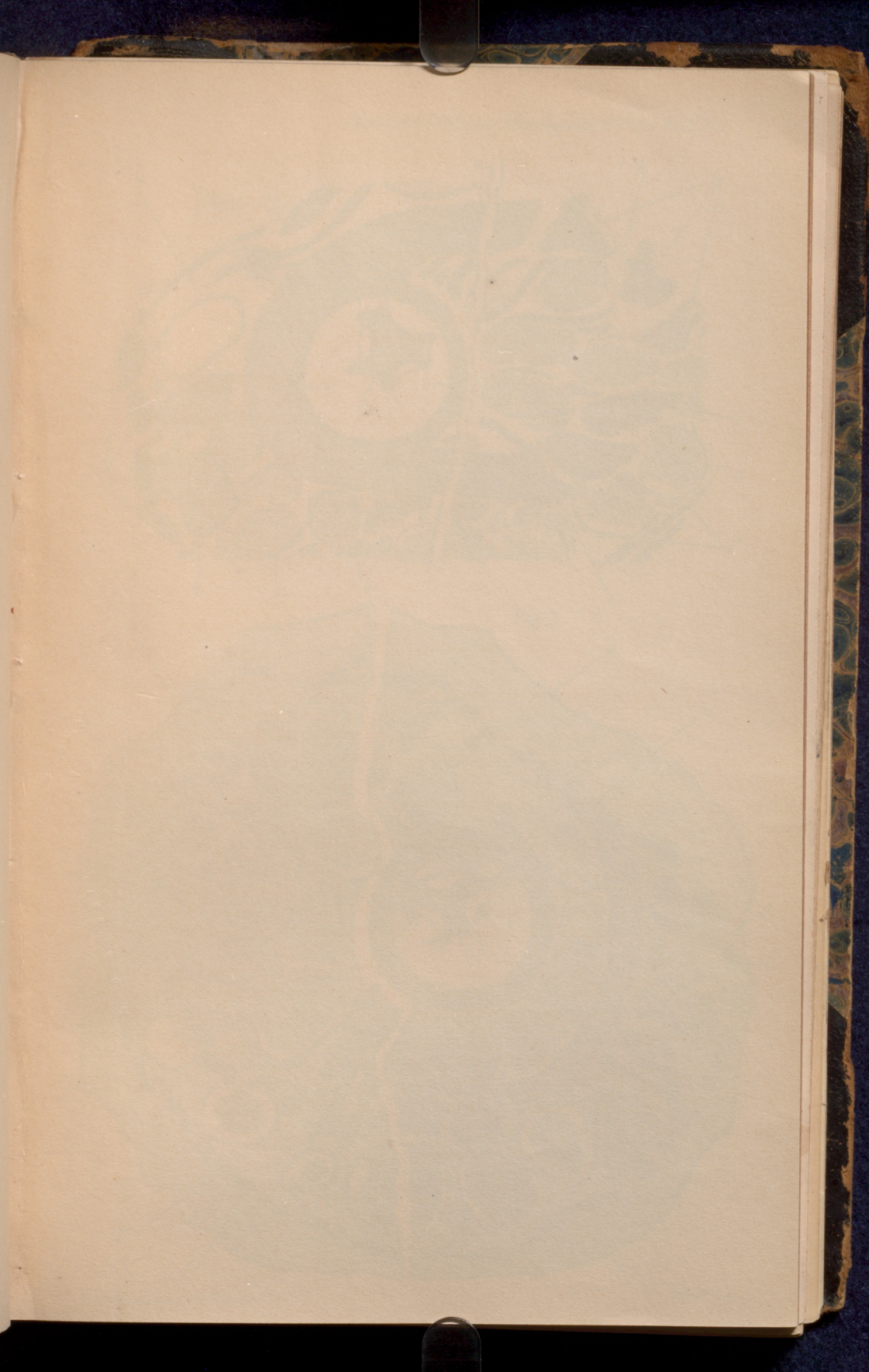
Pl. III.

- Fig. 5. Enlarged representation of the central vascular axis of fig. 3.
- 6. Tangential section, made in the plane of the line *z z* of fig. 1. being intermediate between the section fig. 2 and the exterior of the strobilus.
- 7. Portion of the lowest bractigerous disk on the right of fig. 2, giving off a sporangiophore (*h*) from its upper surface, and exhibiting the prosenchymatous structure of the former organs.

Pl. II.

- Fig. 8. Transverse section of a sporangiophore.
- 9. Three aspects of the spores.

The same letters are employed to indicate identical structures in all the above figures.



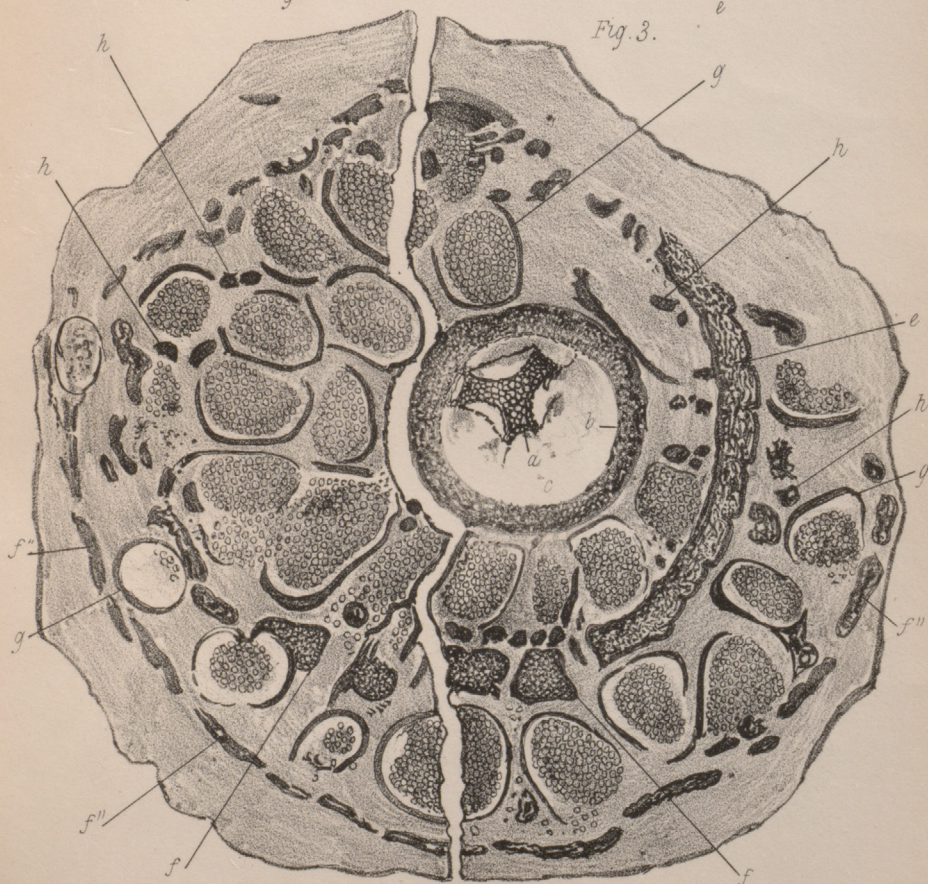
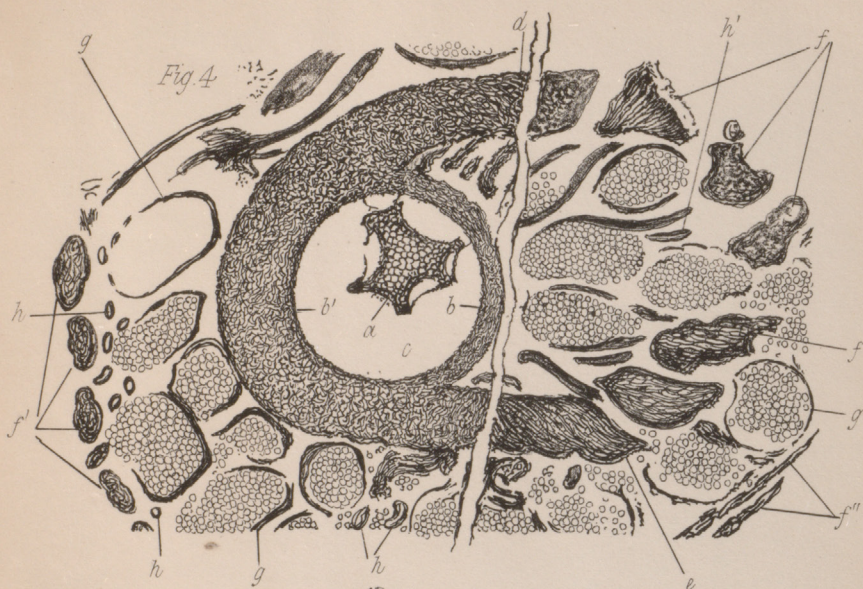


Fig.8

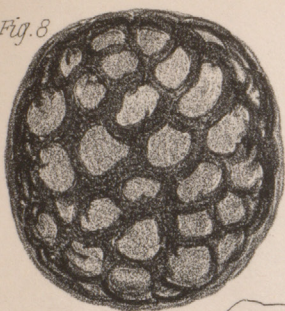


Fig.9.

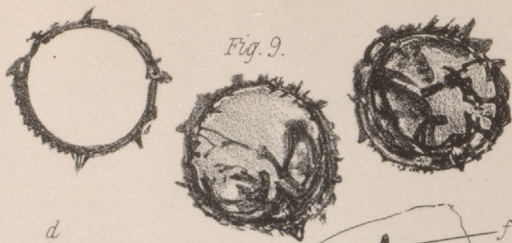
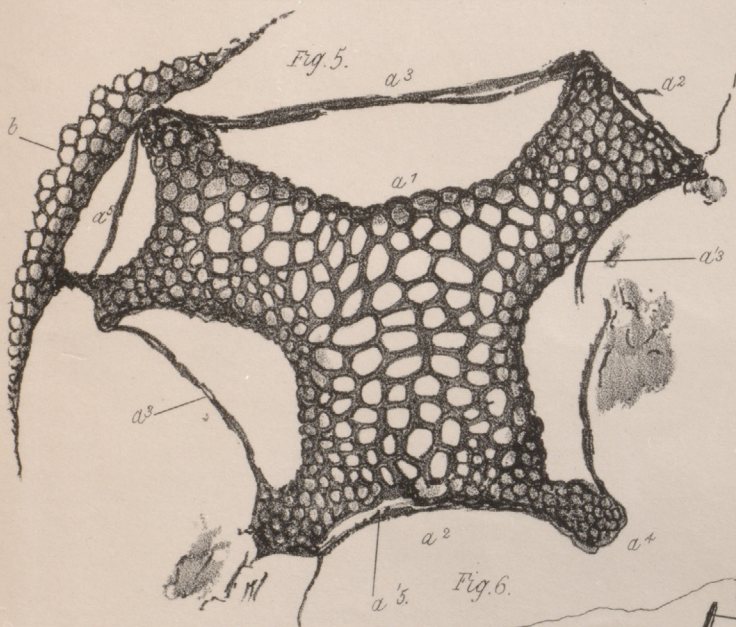
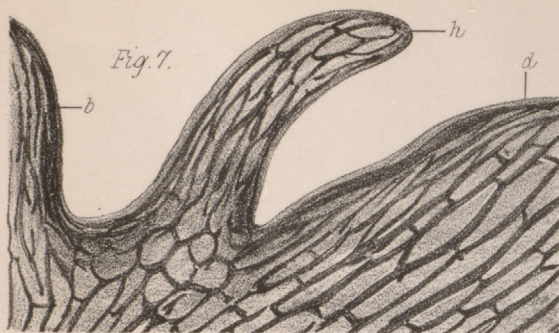


Fig.2



Fig.1





Dr Dawson
with the Author's very
kind regards.

WHILST engaged, some years ago, on an inquiry into the nature of the fossil coal-plants known as *Sternbergia*, my attention was arrested by some structures allied to those found in *Dadoxylon*, but occurring in some stems of *Calamites*. At the same time, the curious specimen represented in fig 1, of which a woodcut was published in the 5th edition of 'Lyell's Manual of Geology' (fig. 478), fell into my hands, and threw new light upon the nature of the small round cicatrices seen at the upper extremity of the longitudinal ridges of each node in many *Calamodendra*. These circumstances led me, in 1852, to prepare numerous sections of these plants from the specimen in my cabinet, represented in fig. 2, in which the structure

was preserved; but as the example only contained the innermost portion of the woody zone, I put the subject aside for a season, in the hope of meeting with further illustrative specimens.

Recently my attention has again been called to the subject by a correspondence with M. Cyrille Grand-Eury, of St. Etienne, who has obtained forms of Calamite altogether different from mine. Other, apparently different, types are in the possession of M. Adolphe Brongniart, of M. Schimper, and of my friend Mr. Binney. It thus becomes probable that several distinct forms of Calamites exist, and that a large amount of combined labour will be required to elucidate their varied aspects. Hence, though my present researches have been chiefly directed to one portion of the structure of one type, it appears desirable that what I have ascertained respecting that type should be recorded for the benefit of others labouring in the same field.

The publication by Sir Charles Lyell of the figure referred to has elicited various opinions respecting the fossil represented. The conclusion at which I arrived was, that the central portion (*a*) was a cast of part of the pith from the base of the plant; that the verticils of radii (*b*), which I would term verticillate medullary *radia*, in contradistinction to medullary *rays*, were prolongations of the pith passing through the woody zone to connect the pith with the bark; that *c* represented the woody zone of the lowermost portion of the stem, whilst *d* represented the exterior of a single articulation of the outer, or cortical layer of the plant.

But several difficulties opposed themselves to this explanation. 1st. The supposition that any *Calamodendron* consisted of two Calamites, one within the other, the one representing the exterior of the pith, and the other the exterior of the bark, was novel, and unsupported by other testimony. 2nd. That the inner structure (*a*) and the

outer articulation (*d*) could not belong to each other, since the former consisted of at least seven or eight internodes, or joints, whilst the outer structure (*d*) was a single joint. It was therefore supposed by some that the central portions (*a*, *b*, and *c*) represented the pith and ligneous zone of one Calamite, which had been accidentally introduced into the interior of the cast of another, when foreign arenaceous material replaced the original vegetable tissues.

In reply to these objections I would urge the following arguments:—That the central pith (*a*) is a true Calamite of the type of *C. Suckowii*, *Steinhauerii*, and others, is unmistakable; that the medullary radii and investing ligneous zone belong to this pith is equally obvious, both the latter facts being demonstrated by specimens to be described in the following pages. The only doubtful point is the relation which these inner structures bear to the supposed bark (*d*, *e*). Now, though the latter consists of one articulation of about two inches in length, it does not follow that it did not belong, like the central pith, to a portion near the *base* of the stem, because we well know how rapidly these nodes increase in size as we ascend from the basal one. The aspect of the woody layer (*c*) demonstrates that it has been prolonged considerably below the base of the pith, or, in a word, that the pith has *not* extended so far downwards as to reach the lowest articulations of the stem; as if, reasoning from living exogenous types, we might regard the latter portion as a pithless root rather than a true stem.

But even were these explanations not sufficient, there yet remains another. The specimen shows that the carbonaceous matter of the ligneous zone (*c*) has been preserved after the cellular structures of the medulla (*a*) and of the verticils of medullary radii (*b*) had been replaced by inorganic sand. I deem it possible that the latter change may have taken place before the woody substance of the supposed

bark (c) disappeared and was similarly replaced. In this case the small portion of ligneous zone thus preserved at the base of the plant might have become slightly detached from its original position, and floated upwards into an internode occupying a higher position in the outer stem than those of which it was originally the centre. The specimen indicates that only about two inches of the lowermost portion of the woody zone had been thus preserved, the external lineaments of the pith and medullary radii having been preserved along with it. I presume that after the base of the plant became imbedded in the stratified sandstone, according to the fashion common amongst the coal-measure plants, the greater portion of the woody contents decayed and floated out, this fragment at its extreme base alone escaping the general decomposition, and being permanently fossilized*.

Which of the above explanations may prove the true one can only be determined by future discoveries; but that the Calamite-like medulla, with its verticils of medullary radii, belongs to the black ligneous zone surrounding it, I shall now proceed to demonstrate from the structure of the specimen represented in fig. 2. This drawing exhibits the appearance of the specimen previous to my cutting it up into sections. It will at once be recognized as consisting of portions of three internodes from the lower part of a stem; owing to the preservation of the innermost portion of the ligneous cylinder, the medullary cast, representing the common type of Calamite, is not seen in its usual form, the transverse constrictions of the latter being here replaced by a projecting mass of organized carbonaceous substance (b), whilst the longitudinal grooves usually furrowing the several internodes are represented by sharply defined

* My friend Mr. Binney, whose extensive experience of Calamites gives weight to his opinion, authorizes me to state that he entirely concurs in the above conclusions.

projecting ridges (*c*) ; these, which lose themselves in the nodes, are separated from each other by more depressed excavated grooves (*d*) corresponding with the elevated longitudinal ridges of the common Calamites. A slight microscopic examination demonstrates that these two features (*c* and *d*) owe their existence to two very different elementary tissues, arranged in vertical laminæ, or wedges, which radiate in alternating series from the medulla to the periphery of the woody zone. It will be remembered that in 1841, Unger, in a work of Petzholdt's ('Ueber Kalamiten- und Steinkohlen-Bildung,' Dresd. u. Leipz. 1841, Tabs. 7 and 8), called attention to a similar arrangement of tissues in the *Calamitea striata* of Cotta, in which one of the alternating structures consisted of *transversely barred fibres*, such as are seen in *Stigmaria*, traversed by medullary rays, and of intermediate tissues composed of smaller and more numerous woody fibres, each radiating series of which had one large central medullary ray. The general type just described resembles, in its broad outlines, what I find in my specimen ; but in their minute details the two plants are different.

As already mentioned, the raised ridges and the intermediate depressions in fig. 2 consist of two very distinct structures, each of the former (*c*) being composed of numerous longitudinally disposed vessels of a reticulated type, whilst the latter consist of oblong prosenchymatous cells. In the transverse section, both these structures are seen arranged in the same manner, radiating in *equally regular* parallel lines from centre to circumference. I shall henceforth speak of these alternating structures as composing the *vascular* and the *prosenchymatous* tracts.

Fig. 3 represents a portion of a transverse section made in the centre of an internode, as at 2 *a*, the figure being almost limited to two of the vascular tracts and an intervening prosenchymatous one. As the crenulated outline

marking the junction of the woody zone with the pith (fig. 3 *a*) indicates, the portions *c, c* radiate from two of the longitudinal furrows characteristic of an ordinary Calamite, whilst *d* corresponds with one of the intervening prominent ridges. The portion *c* consists of the transversely divided mouth of vessels, having a diameter of from $\frac{1}{600}$ to $\frac{1}{700}$ of an inch; they are arranged in from 20 to 25 regular rows, radiating from the pith (*a*) to the periphery of the woody zone. At their medullary extremity these rows of vessels combine to form a sharp woody wedge (*c*), which fits into one of the longitudinal grooves of an ordinary Calamite.

The appearance presented by these vessels when more highly magnified is seen in fig. 4, where portions of two tracts are represented. The walls of each tube do not appear to have been very thick; but it is difficult to determine exactly how much of the substance represents the original woody tissue, and how much is due to subsequent mineral infiltration. There is now no hollow cavity within each vessel.

The prosenchymatous cells forming the intermediate tracts (fig. 3 *d*) have a larger diameter than the cells, averaging about $\frac{1}{400}$ of an inch. They are also more symmetrically arranged in linear series; but in other respects their distribution resembles that of the vessels just described. They radiate from within outwards in from 30 to 35 regular lines. When more highly magnified (fig. 5), each cell appears to have thick walls, like those of recent woody fibre, which I at first believed these tissues to be; but I think that the appearance in question is due to mineral infiltration, and that the true walls of these cells were thin. It will be observed that, in this section, their regular radiating arrangement is that of the pleurenchyma or true woody fibre of coniferous stems, rather than that of ordinary cellular tissue, or parenchyma.

Fig. 6 represents part of a tangential section, the letters *c* and *d* being used to indicate the same parts as in the last figure. We here see that the vessels (fig. 3 *c*) run from one articulation or internode to the other, in the shape of elongated tubes, arranged like the fibres of living Conifers, and separated at intervals by numerous medullary rays (fig. 7 *e*) consisting of vertical layers of cells, arranged in single series. The surfaces of the vessels in this section often display no trace of structure; but here and there we obtained distinct evidence that their walls were strengthened internally by woody reticulations. The intermediate prosenchymatous tracts (fig. 6 *d*) consist, as already stated, of oblong cells (fig. 8) of fusiform shape, but which do not exhibit, *in this aspect*, the regular serial arrangement that is so conspicuous in the transverse section; medullary rays appear almost, if not wholly, absent from this part of the structure. In only two instances have I detected anything that could be mistaken for such a ray; and these were possibly nothing more than a few linearly arranged cells, shorter than the rest.

On making a vertical section of a vascular tract (figs. 2 and 3 *c*) in the plane of a medullary ray (fig. 9), we discover that the vessels (9 *c*) are still regularly arranged in parallel series; and, on applying a high magnifying-power, we find their surfaces to be covered with small reticulations, arranged in an irregular order (fig. 12), but usually with from three to four contiguous areolæ between the two sides of each vessel. These reticulated vessels very closely resemble those seen in some varieties of *Dadoxylon*. The reticulations have no central dot, consequently they must not (as Mr. Carruthers has already pointed out) be confounded with the disks of true glandular fibre. This section reveals the form and arrangement of the cells constituting the medullary rays (9 *e*). They have thin walls, and are arranged in a muriform manner; only the long axis of each cell is often

vertical instead of horizontal as is common in living plants. In other respects they appear to be distributed as is usual amongst Coniferæ, strongly reminding us of their arrangement in the carboniferous genus *Dadoxylon*.

Thus far I have confined myself to a description of the woody zone in its undisturbed form, as it appears in the middle of the internodes; but at and in the neighbourhood of the nodes or articulations (fig. 2 *b*) a remarkable modification occurs. As is well known, each of these nodes is represented in the common type of Calamite by a circular transverse constriction; but in the living plant it was merely an indentation of the pith, occasioned by a projecting lenticular ring of woody tissue, of which the medullary margin was somewhat wavy, or projecting at points corresponding with the longitudinal grooves into a series of small irregular teeth.

Fig. 10 represents a vertical section of this structure, as seen under a very low magnifier, *a* indicating the pith, and *b* the woody lenticular ring.

Fig. 11 represents a more highly magnified view of one of the tooth-like projections from this ring, as seen in its horizontal section. The cellular clusters at its internal angles (*i, i*) probably belonged to the pith.

I have already called attention to the remarkable series of horizontal verticils of cylindrical prolongations of the pith seen in fig. 1. It is well known that in many fossil Calamites, at the uppermost part of each longitudinal ridge of the several joints there is a small round mark or cicatrix, to which various functions have been assigned. The example figured indicates that wherever such marks occur, the specimen bearing them is a pith, and that the marks are merely the points from which what I have termed the verticillate medullary radii spring. In nearly every specimen hitherto found these radii have disappeared along with the woody zone which they penetrated,

the example figured being the only one of its kind that I have either seen or heard of during thirty years of association with the plants of the coal-measures. These radii appear to have been composed of the same tissue as the medulla itself, judging from the circumstance that the inorganic material with which they are filled is identical with that replacing the pith*; they have most probably united the pith with the bark. As this function was amply performed by means of the medullary rays in the fibrous tracts, we must assume that the *radii* had in addition some undiscovered special functions of their own. On turning to the tangential section (fig. 6), we find that a radius (6 *f*) penetrates the centre of the upper extremity of each cellular tract (*d*), in which portion it will be remembered there are no true medullary rays—a circumstance which indicates that the prosenchymatous tracts are not merely prolongations of the pith, since true prolongations of the latter passing through them have retained their separate forms. Each radius is cylindrical, somewhat compressed laterally, and occasionally, but not often, rather triangular. In figs. 10 *f* and 17 *f* we see its position in reference to the node of the woody zone, having a mass of vascular tissue (*c*) above, and the prosenchymatous tissue (*d*) below it. A very limited portion of the latter tissue, peculiarly deflected, interposes between the upper surface of the radius and the remarkable articular or nodal arrangement of the vascular elements next to be described.

It must be remembered that the longitudinal grooves of Calamites usually alternate in contiguous joints or internodes, the elevated ridges of one joint being continuous

* My friend Mr. Carruthers has suggested that the scars left when these radii are broken off represent the openings of meshes in the woody tissue through which *vascular* bundles passed to whorls of leaves or branches produced at the nodes (Geol. Journal, July 1868, p. 332); but my specimens do not sustain this opinion for the reasons given in the text.

with the furrows of the adjoining ones, though occasionally no such alternation takes place. In the former case, one of the radiating vascular tracts would, if prolonged straight upwards through the node, run into a prosenchymatous tract of the joint above. In the exceptional instances, the vessels are prolonged through the node with little disturbance, and continued into the corresponding vascular tract of the next joint. In both cases the vessels of the various articulations are shown to be continuous. This alternation in the arrangement of the tracts causes peculiar modifications in the disposition of the vessels on crossing the node.

Three disturbing elements exist at the articulation,—1st, the verticillate medullary radii; 2nd, the verticils of vascular bundles; and, 3rd, the alternation of the tracts.

Fig. 13 represents a transverse section almost in the plane of the verticillate radii; exactly so on the left of the figure, but traversing their upper surface to its right: *a* represents the pith, *f* the several medullary radii, and *c* the woody wedges which separate the latter. In fig. 14 one of these wedges is shown more highly magnified. It consists of from 30 to 40 radiating series of vessels, arranged like the fibres of most recent Coniferæ; but at its two outer margins are a very few rows of larger structures (*d*), which we find to be sections of the outermost rows of prosenchymatous cells seen in fig. 3 *d*, some of which, as already shown in fig. 6, separate each medullary radius from the nearest vascular tracts. At its inner extremity each wedge is pointed, having its two sides slightly excavated; hence across the centre of fig. 13 we have a crenulated outline of the pith, readily recognized as representing a section of the exterior of an ordinary Calamite. At this point of the stem the regular arrangement of the vessels has undergone little disturbance, space for the passage of the medullary radii being obtained at the expense of the

prosenchymatous cells. This is shown in figs. 6 and 15, in both of which a thin layer of cells is seen, both above and at each side of each radius (*f*). But the case is altogether altered in the plane above the radii corresponding with the centre of the node.

At this point the radiating vascular laminæ forming the wedges *c* in fig. 13 become detached from each other by the intrusion of cellular masses, as seen in fig. 16. Sometimes these cells are in a single row (16 *g*), when they are undistinguishable from the ordinary medullary rays; at others, as at 16 *h*, *h'*, we have unmistakable proof that they are identical with the fusiform cells of the prosenchymatous cellular tracts (fig. 6 *d*). It appears that at each node the fusiform cells and the muriform ones of the medullary rays become blended and undistinguishable from each other, a connexion being thus established between these tissues at each articulation, such as does not exist in the inter-nodes.

It is almost impossible to describe or delineate the wonderful meanderings of the vessels as they ascend across the node. One object of their windings is their redistribution to the two nearest vascular tracts immediately above the node. Fig. 15 attempts a representation of this singular rearrangement, the same thing being partially shown in the upper part of the similar tangential section (fig. 6). The vessels of the vascular tract (15 *c*) diverge as they pass between the two medullary radii (*f*, *f*), to be redistributed to the vascular tracts (*c'*, *c'*), part going to the one and part to the other, whilst many are deflected hither and thither, as if unable to decide which course to take. Throughout all these serpent-like contortions we have abundantly displayed the arrangement represented in fig. 16. But the most remarkable feature connected with this redistribution is seen above the vascular tract (15 *c*), at the portion of the node immediately below the pros-

enchymatous tract (*d*) of the internode above. At this point we have appearances that vary in different examples. Sometimes, as in fig. 6 *d'*, we have a number of long sinuous vessels, converging at a central point, where we find a small cluster of similar but transversely divided ducts, with a few cells in its centre; at others, as in fig. 15, these *transversely divided* tubes occupy a much larger portion of the area, whilst their open orifices radiate in somewhat regular lines from the central point, which consists, as before, of a small cluster of transversely divided cells. Around the margin of this circular area, which closely resembles a transverse section of some coniferous branch, we again find the long vessels, bending away in the plane of the section, to contribute their respective shares to the two vascular tracts 15 *c'*, *c'*. A vertical section, made in the plane of a medullary ray, enables us to interpret these appearances. As the vessels of the vascular tracts approach a node, instead of following the outline of the pith, as in the rest of their course, they are suddenly deflected from it, bending outwards in parallel arched curves, but return to their original direction after passing the node. Mr. Binney found a similar arrangement in his *Calamodendron*. Fig. 17 is a diagram designed to explain these appearances. It represents a section somewhat like that shown in fig. 10; but in order to illustrate the relations of the several parts to the medullary radius, the diagram is made to represent an oblique section, passing from fig. 15 *f* on the left to *c'* on the right of the same figure. But the arched vessels (17 *c*) must be understood to pass downwards, *on each side* of the medullary radius (17 *f*), and not to terminate abruptly at the latter, as the diagram indicates.

But, in addition to these arching vessels, we have at the nodes numerous groups of divergent vessels (17 *e*), varying in diameter in different parts of the plant, which

proceed directly outwards towards the bark. It is one of these groups, transversely divided, which produces the appearance of a transversely divided branch, seen in fig. 15. In the centre of the latter group the cells and vessels are divided at right angles to their longer axes, whilst the peripheral ones run in the plane of the section. I think there can be no doubt that this arrangement was destined to supply some external appendages of the main stem with vascular tissue. Whether these appendages were branches or leaves is doubtful; but I incline to the former opinion.

Mr. Binney has recorded somewhat analogous arrangements in his Tab. 3. fig. 4.

Before attempting to interpret the facts which I have described, a further glance at the discoveries of some other recent observers is necessary.

Nothing could be more unsatisfactory than the state of our knowledge of the internal structure of the stems of Calamites prior to the investigations of M. Unger; and valuable as those were, they only threw light upon one branch of the question. Guided by that light, M. Adolphe Brongniart suggested, in his 'Tableau des genres de Végétaux Fossiles'*, that two distinct groups of plants had hitherto been confounded under the name of Calamites. He proposed that these should henceforth be separated, retaining the old name for one section, which he regarded as allied to the *Equisetæ*, and employing the generic term *Calamodendron* for the other, which he thought ought to be ranged amongst the Gymnospermous Dicotyledons. The structure of the genus *Calamitea* of Cotta, as demonstrated by Unger, is regarded by M. Brongniart as typical of his *Calamodendron*. He describes this genus as exhibiting, amongst other features, a woody cylinder composed of large radiating vertical tracts of transversely barred vessels intermingled with true medullary rays, alternating with

* Dictionnaire Universelle d'Histoire Naturelle.

corresponding tracts, composed of masses of a peculiar form of woody fibre, with one large medullary ray in the centre of each tract.

My friend Mr. Binney has thrown further light upon this subject in his volume 'On the Structure of *Calamites* and *Calamodendron**', which only came into my hands after the previous pages had been written. Mr. Binney does not attempt to separate *Calamites* from *Calamodendron*, but contents himself with describing his specimens, which are of great interest. The woody cylinder of every one of them essentially resembles that examined by Unger, in consisting of radiating alternate tracts of barred or scalariform vessels, and of coarse cellular tissue. This copious development of scalariform vessels demonstrates that Mr. Binney's examples present the same type of organization as the *Calamitea* described by Unger.

Dr. Dawson, of Canada, detected in *Calamodendron* some traces of what he terms "wood-cells, with one row of large pores on each side"†. And in another part of his paper he again refers to them as tissues in which "the disks or pores are large and irregularly arranged, either in one row or several rows." Of course neither of these descriptions exactly agrees with the reticulated fibres of my plant; but as Dr. Dawson expressly associates his examples with the fibres seen in *Dadoxylon*, I conclude that he may have met with a *Calamodendron* of a type approaching nearer to my plant than to those of M. Unger and Mr. Binney.

Dr. Dawson has further illustrated this subject in the 2nd edition of his 'Acadian Geology,' where he figured

* Observations on the Structure of Fossil Plants found in the Carboniferous Strata, by E. W. Binney, F.R.S., F.G.S.—Part 1. *Calamites* and *Calamodendron*. London, printed for the Palæontographical Society, 1868.

† "On the conditions of the deposition of Coal, more especially as illustrated by the Coal-measures of Nova Scotia and New Brunswick," Quarterly Journal of the Geological Society, vol. xxii. 1866.

the tissues* referred to; but none of his figures correspond exactly with the vessels of my plant, fig. 163 E alone exhibiting an approach to a resemblance.

Be this as it may, we now have suggested to us the possible existence of three types of *Calamodendron*, in each of which the stem consists of woody wedges, disposed vertically around the pith from which their component laminae radiate, and which are separated from one another by alternating vertical cellular masses either of parenchyma or prosenchyma, which latter connect the pith with the bark. But if the descriptions of Mr. Binney and Mr. Carruthers are correct and generally applicable, it is also obvious that, though constructed on a common plan, important differential characters separate two of the types from the third. In Mr. Binney's plants the woody wedges are exclusively composed of scalariform tissues, and appear to contain no true medullary rays. On this point Mr. Carruthers speaks strongly, and relies upon the fact as one evidence of the Cryptogamous character of these fossils†; and Mr. Binney does not appear to differ materially from Mr. Carruthers. He figures in his plate 3. fig. 6 what he terms "medullary (?) bundles;" but these are the representatives of my prosenchymatous tracts, and not of the muriform medullary rays.

The thick radiating cellular laminae separating the woody wedges in Mr. Binney's specimens consist of ordinary parenchyma. In Unger's *Calamitea* the woody wedges consist, as in Mr. Binney's examples, of scalariform tissue (vaisseaux rayés); but these vessels are separated by "des rayons médullaires très-étroits, d'un seul rang de cellules, et peu étendus en hauteur" (Tableau des genres de Vé-

* *Loc. cit.* figs. 162 c, d, and 163 E.

† "On the Structure and Affinities of *Lepidodendron* and *Calamites*, by W. Carruthers, Esq., F.L.S." Seemann's Botanical Magazine, Dec. 1866; see also Journal of Botany, Dec. 1867, "On the Structure of the Fruit of *Calamites*."

gétaux Fossiles, &c., extrait du Dictionnaire Universelle d'Histoire Naturelle, 1849, p. 50), which obviously correspond to my true medullary rays. The intermediate cellular laminæ consist of what Brongniart terms "woody fibres" (fibres ligneuses), but which appear to be identical with my prosenchymatous tissue, each layer having in its centre what he terms one large medullary ray composed of two or three vertical rows of cells. In my plant the woody wedges are constructed, like Unger's *Calamitea*, of elongated vessels, separated by numerous medullary rays; only the vessels are reticulated instead of scalariform. The intermediate cellular tracts also appear to resemble Unger's, consisting, as I have shown, of a peculiar prosenchymatous tissue. I find here nothing like the central medullary ray of Unger; but instead of it we have the large verticillate medullary radius in the upper extremity of each prosenchymatous tract. Thus we learn that Unger's plant has the scalariform vessels of Mr. Binney's type, with the medullary rays of mine, and constitutes, in these respects, an intermediate link between the two.

The prosenchymatous tissue is of considerable interest on several grounds. When divided vertically, whether on the plane of the medullary rays or tangentially, the cells appear to be arranged in no special order beyond what we see in many compressed forms of parenchyma. But when we turn to the transverse section, we discover the regularly linear radiating arrangement which I have described, and which is so characteristic of vascular tissues, as well as of the pleurenychymatous elements of Gymnospermous Exogens. From their occupying the same position as the cellular laminæ of other *Calamodendra*, which are unquestionably prolongations of the pith, we might almost regard them as huge medullary rays. These, however, as we have seen, exist in addition to them. They so closely resemble, in their linear arrangement, the pleurenychyma of conifer-

ous wood, that it is difficult to regard them otherwise than as an elementary form of simple pleurenychyma, or woody fibre. But it is their elongated shape, the obliquity of their overlapping extremities, and their radiating disposition in the transverse section which give them that character, and not the existence of ligneous deposits in their interior.

The conspicuous occurrence of these prosenchymatous cells in a Calamite acquires additional interest from the circumstance that they are identical with those already described by Mr. Binney, under the name of "elongated utricles," as occurring in *Sigillaria vascularis**. In that plant the outer of the two woody zones which the stem contains is entirely composed of this peculiar tissue; but physiologically the fact deserves notice that, as Mr. Binney points out, it gradually passes into the ordinary parenchyma of the inner part of the stem. I may further observe that small masses of the same tissue, also disposed towards an arrangement in radiating lines, constitutes the external ridges of the living *Equisetum limosum* and its allies. Longitudinal strips, torn from the epiderm of that plant and viewed from within, exhibit an alternate arrangement of longitudinal bands that strikingly resembles what we find in tangential sections of *Calamites*; only the long vascular tracts of the latter are wanting in the recent plant, their place being occupied by cellular tissue. May we regard this prosenchyma as a rudimentary form of pleurenychyma? Dr. Dawson refers to the same tissue under the name of "bast-tissue;" but this term is only appropriate to true pleurenychyma, and not to the more rudimentary type under consideration.

We may now inquire what are the true affinities of these various forms of *Calamites*? Schimper, Carruthers, and

* "A Description of some Fossil Plants, showing Structure, found in the Lower Coal-seams of Lancashire and Yorkshire, by E. W. Binney, Esq., F.R.S." Phil. Trans. 1865, p. 591.

Hooker are disposed to regard the type described by Binney and Unger as Equisetaceous. On the other hand, though M. Brongniart believes in an Equisetaceous form of Calamite, he does not regard the above examples as belonging to it. He considers that they are *Calamodendra*, which he places amongst the Gymnospermous Exogens. Are we yet in a position, in the face of these discrepant opinions, to arrive at a conclusion on the moot point? The importance now attached to the doctrine of evolution gives significance to the question, and renders an answer desirable.

The inferiority of the cellular to the vascular plants is obvious and admitted. When we ascend to the vascular Cryptogams, we find that they retain indications of their natural alliance with the cellular forms, in having the vascular elements largely intermingled with cellular ones; whilst in the Gymnospermous Exogens the purely cellular element is almost eliminated from their woody layers, being only represented there by the medullary rays. Viewed in this aspect, Mr. Binney's *Calamodendron* appears to approximate to the recent Acrogens, in whose stems cellular and prosenchymatous tissues are abundant, combined with vessels of a scalariform type, but which, so far as I know, exhibit neither reticulated vessels nor medullary rays. But when we ascend to the Gymnospermous Exogens, we find the cellular element disappearing, whilst vascular tissues present themselves, chiefly in a reticulated*, spiral, scalariform, or glandular form. In my plant, whilst we have abundance of muriform medullary rays, we have few if any transversely barred vessels; every duct of which the structure can be traced is distinctly reticulated, whilst the prosenchymatous cells, as we have seen, assume

* I may observe that a small form of reticulated pleurenchyma, apparently almost identical with the reticulated vessels of my plants, enters largely into the woody zone of the living *Araucaria imbricata*.

a pleurenchymatous arrangement and aspect; so that in all these respects my specimen approaches nearer to the Gymnospermous Exogens than to the Acrogens. In the *Sigillaria vascularis* described by Mr. Binney (Phil. Transactions, 1865), we find abundance of the identical form of prosenchyma seen in my Calamite, associated with cellular tissue, scalariform vessels, and muriform medullary rays; whilst in *Sigillaria Brownii*, according to Dr. Dawson, we have an inner cylinder of scalariform vessels surrounded by an outer one of true glandular fibre.

It is clear that all these plants exhibit, so far as their stems are concerned, indications of mutual affinity with Acrogenous Cryptogams on the one hand, and with Gymnospermous Exogens on the other. The prevalence of cellular and scalariform tissues points in the former direction, whilst the arrangement and apparently exogenous mode of growth, both of their vascular and prosenchymatous elements, are suggestive of the latter. This is especially the case with the Calamites, which seem to me to constitute a well-defined link, connecting the Exogens with the Acrogens.

But whilst it appears reasonable to locate the Calamites, as a whole, in the position just indicated, the minor differences which the several types seem to present suggest the necessity for some change in their generic grouping. I would therefore propose that, until the correctness or otherwise of Brongniart's opinion that there exists an Equisetiform class of Calamites is determined, we retain his two genera of *Calamites* and *Calamodendron*. The genus *Calamites* to embrace all the Equisetaceous forms, if any such really exist, whilst *Calamodendron* may comprehend the *Calamitea* of Unger, and possibly Mr. Binney's specimens, the genus being characterized by the prevalence of *scalariform* vessels and medullary rays, and by the absence of verticillate medullary radii.

In addition, I would suggest the establishment of the new genus *Calamopitus* (κάλαμος-πίτυς) for those forms in which the woody elements consist of *reticulated* vessels associated with medullary rays, and having verticils of medullary radii near the nodes*.

The exact value of these medullary radii, as indicative of a generic distinction, remains to be ascertained, as well as the extent to which they are associated with reticulated vessels. If it should be found that they occur in *Calamites* with scalariform vessels, or if *Calamites* having none but reticulated vessels exist without traces of verticillate medullary radii, then it may be necessary to abandon the term *Calamopitus*, and associate the whole series as variable examples of Brongniart's genus *Calamodendron*. At present, however, we know that neither Binney's nor Unger's plants possess the verticillate radiating prolongations of the pith. They are also absent from silicified *Calamites* from Autun, of which M. Brongniart showed me fine specimens many years ago, and which, he now informs me, are identical with Mr. Binney's plants. Dr. Dawson says that true *Calamites* "can always be distinguished" [*i. e.* from piths of *Calamodendra*] "by the scars of the leaves or branchlets which are attached to the nodes." But my plants indicate precisely the opposite conclusion to this, viz. 1st, that such scars appear to

* I do not altogether like this arrangement, because I have the strongest doubts respecting the existence of an equisetiform type of *Calamitea* part from what Mr. Binney has described. I should have preferred applying the old generic name *Calamites* to Mr. Binney's plants, and assigning Brongniart's term *Calamodendron* to my own. But when an author founds a genus, he is entitled to define it, and M. Brongniart has distinctly identified *Calamodendron* with a vascular zone consisting of scalariform vessels and true medullary rays. The plan proposed presents the further difficulty that, if Mr. Binney's specimens are really deprived of medullary rays, that important characteristic feature will exclude them from *Calamodendron*, and involve the necessity for establishing an additional genus for their reception. But as I regard this as a doubtful point, I am not, at present, prepared to separate them from *Calamodendron*.

belong exclusively to medullary casts ; and, 2nd, that they are *not* the scars of leaves or branchlets. I am confirmed in this conclusion by the fact that, though these scars are very distinct on those joints of the pith of the specimen represented in fig. 1, from which the verticillate medullary radii have been broken away, *they are wholly absent from the longitudinal ridges of the exterior of the specimen.* If, as I believe, mine is a correct interpretation of these scars, we must abandon the notion that they were due to internal vascular bundles, or that they were scars occasioned by the separation of external branches ; and, as a consequence, the verticillate arrangement of the branches suggested in the restorations of Dr. Dawson will fail to be sustained, *so far as it rests upon the position of these scars*, though supported by other facts. Of the external appendages of my plant as yet I know nothing. Since the axes of the cones described by Mr. Binney are characterized by the presence of scalariform tissue, they must belong to his plant rather than to mine ; and there seems no reason to doubt that some species of *Asterophyllites* also represent the foliage of the same. All that we know respecting the structure of my plant externally to the woody zone is suggested by fig. 1, where we have a very thick layer of sandstone surrounding the woody cylinder, and which must be regarded as representing an equally thick bark. Whether the longitudinal flutings of its exterior really indicate the outermost part of the bark, or whether this, in turn, has been invested by an epidermal layer, represented by the thin covering of coal with which such Calamites are frequently covered, has yet to be determined. Of its growth we know nothing beyond the fact that the plant has developed offshoots from the base of its central stem, as appears obvious from the common occurrence of stems the lower extremities of which exhibit a strongly marked lateral curvature.

I believe that the two specimens described are both from the upper coal-measures. Fig. 1 was found in a sandstone quarry near Oldham; and though I am doubtful respecting the precise locality whence fig. 2 was obtained, I believe that it came from near Peel. I have a similar specimen from the Peel Delf-rock, near Worsley, a sandstone belonging to the Upper Coal-measures.

Since reading the preceding memoir, I have had the advantage of studying a very beautiful and important series of sections of carboniferous plants, prepared and chiefly collected by Mr. J. Butterworth, of High Crompton, near Oldham. Amongst these are several instructive sections of Calamites. This valuable contribution to microscopic science requires me to modify one or two conclusions at which I had previously arrived, since the specimens render plain several points which were formerly obscure. Most of them correspond very closely with Mr. Binney's examples in having the vascular tracts composed of scalariform vessels. *But in one I can trace a decided transition from the scalariform to the reticulated type*, thus suggesting the possibility of a link between Mr. Binney's specimens and my own. Nor is this all; in other specimens I find the cellular tracts most variable in their structure. Sometimes the cells are elongated *transversely*, so that one long cell extends horizontally across the cellular tract, reaching from one vascular tract to another. In another example the reverse is the case; the cells are much elongated vertically, but have rectangular extremities. In *the same* tract these rectangular cells pass into the prosenchymatous type, in which the ends of the cells diagonally overlap each other; and yet in the same specimen are parts of corresponding tracts in which the cells are of the ordinary

parenchymatous type seen in Mr. Binney's plants. But whilst on these points Mr. Butterworth's specimens exhibit so many features in common with Mr. Binney's, as in mine, the woody tracts are *all* provided with some medullary rays. This structure identifies these specimens with the *Calamitea* of Unger, and makes it more probable than before that a further study of Mr. Binney's fine examples will reveal medullary rays in them also. The only absolute and permanent distinction that still appears to separate my type of stem from the rest is the existence of the verticillate medullary radii, which are equally absent from all other described forms, but which alone I should scarcely regard as constituting a sufficient basis for a generic distinction.

But, as I shall presently show, there are other circumstances which justify the provisional retention of my genus *Calamopitus*. Mr. Butterworth's specimens accord in a remarkable degree with my description of the curious arched deflection of the barred vessels from the surface of the pith when passing the nodes, and also reveal traces of vascular bundles passing from the interior to the exterior of the woody zone at the same point, as indicated in my fig. 17; but this arrangement is much less complicated than in my examples. The vessels of each vascular tract ascend in a compact form until they reach the node; they then divide right and left to be distributed to the two contiguous vascular tracts above. Each bundle undergoes no change in doing so, beyond bulging out somewhat to admit of a large admixture of cells like those of the cellular tracts, returning immediately to the former compact arrangement as the diverging bundles enter their respective vascular tracts in the joint above. The specimens indicate that the exterior of the woody zone had a furrowed Calamite-like outline, the external ridges corresponding with the *vascular* tracts, whilst the de-

pressions marked the external line of the *cellular* ones—an arrangement reversing that which these structures bear to the surface of the pith.

But Mr. Butterworth's collection has, in addition, furnished me with the cone of my plant. It has been of much larger dimensions than those described by Mr. Binney, as well as much more complex in its internal structure, and otherwise distinct; but that it belonged to my plant, is shown by the reticulated vessels of its central axis, as well as by their curious arched arrangement when crossing the nodes—an arrangement to which I have already referred as constituting so remarkable a feature of the plant which I have described. From this axis there are given off at each node ten well-defined radiating peduncles, each of which divides into bract-like appendages, which bend first downwards, and then curve upwards and outwards, first sending upwards into the cone two sporangium-bearers. The sporangia have walls consisting of a single layer of oblong tabular cells, and their interior is filled with defined cellular tissue. Each spore seems to be a spherical body, consisting of two layers, exhibiting no trace of elaters or external appendages. I have but briefly indicated a few of the features of this beautiful cone, because its more minute and elaborate features demand that I should devote to it a separate memoir, which I hope to be able to lay before the Society at an early date. The peculiarities of this cone seem to justify the establishment of the genus *Calamopitus*.

All the additional facts which Mr. Butterworth's invaluable specimens have revealed confirm my previous conviction of the close affinity existing between the structure and growth of the woody wedges of my Calamite and corresponding wedges taken from the stems of some *Dadoxylons*. Of course this resemblance implies that in their growth these wedges have been exogenous, which is

unquestionably true. So far I agree with the opinion always held by M. Adolphe Brongniart respecting the stems of his genus *Calamodendron*. But that distinguished botanist has further held that these plants were *Gymnospermous* Exogens, which of course involved reproduction by means of stamens and pistils, and which, as I have just shown, is not the case. The cone to which I have referred is unmistakably Cryptogamic in its type. The same remark applies to the cones described by Mr. Binney. The conclusion, therefore, at which I arrive is, that the Calamites constitute essentially *one* large group of plants, with some considerable range of variation in the details of their internal organization; but not more than exists in many well-defined family groups of living plants, as, for example, the Equisetaceæ; that their stems were exogenous, so far as the woody cylinder was concerned, and closely related to those of the Dadoxylons. But, on the other hand, their fructification was Cryptogamic, but not necessarily Equisetiform, though not without some features of resemblance to that type of recent Cryptogams. Thus we have in the Calamite a combination that appears to have no living representative. Mr. Darwin may fairly point to these plants as indicating a generalized structure which at some later period became differentiated, through the Dadoxylons of the carboniferous rocks and the true *Equiseta* of the Oolites, into the modern types of Coniferous and Equisetiform plants. It must be remembered, however, that these Dadoxylons are not *all* true Conifers like the living types. We have not yet found in them, with one exception, the peculiar glandular disk, with its central spot, which occurs in all the modern Coniferæ, even in the Cycadeæ. Consequently these supposed Conifers themselves may ultimately be shown to constitute an additional connecting link between the ancient and modern types of gymnospermous vegetation. Every ad-

ditional study of the older fossil plants, including those of the Oolitic age, makes plain the difficulty, if not the impossibility, of identifying them exactly with living types. Special organs may and do exhibit close resemblances; but the general combinations are frequently different. In this respect the recent Cycads retain something of the features of the more ancient vegetation. In their stems we find the scalariform and annular vessels of the Acrogens side by side with the gymnospermatous inflorescence and the Araucarian forms of glandular tissue linking them with Conifers, whilst in one aberrant genus (*Stangeria*) we have the stems and cones of Cycads combined with the foliage and nervures of a true Fern. The differentiation which has been so complete in other plants appears to have remained unaccomplished in the Cycadeæ.

Various attempts have been made to *restore* the Calamite, as well as the other plants of the Coal-measures; and though such attempts have been hitherto, and still are, premature, they are not altogether useless, since they mark the successive stages of progress towards truth. In the instance of the Calamites, we have especially the restorations of M. Deslongchamps, given in the 'World before the Deluge,' of Louis Figuier, and those of Dr. Dawson (Acadian Geology, 2nd ed. p. 442). The former represents the plant as giving off from its central stem large bushy branches, like those of some modern Araucarias. To this idea the structure of the woody zone affords no support. If any *large* branches had sprung from the main stem, the structure of this zone would have shown unmistakable evidences of the fact in the lateral deflection of large masses of vascular tissue. But I see no evidence of such large deflections. We have deflections on a small scale; but the diameter of the largest and thickest of these divergent vascular bundles never exceeds the breadth of one of the longitudinal ribs of a Calamite; hence the vascular

portions of these appendages must have been slender. At the same time I infer that they have been something more than leaves, from the arrangement of the vessels of these bundles when seen in a transverse section; they exhibit, as is seen in fig. 17, the radiating arrangement of a woody twig, rather than what we should expect in vessels merely destined to supply a leaf. The only wonder is, that lateral appendages so freely supplied with vascular tissues should ever be deciduous, which those of the Calamite seem to have been, or we should frequently find them *in situ*, which has not yet been done. The difficulty is partially surmounted by the supposition that such small branches were jointed, and exceedingly slender, especially at their points of attachment to the stem; and we find such slender-jointed twigs in the Asterophyllites, to which so many observers have referred as probably constituting the branches and foliage of Calamites. With this decision I am strongly disposed to agree. For the above reasons I regard the restorations of Dr. Dawson as approaching nearer to the truth than those of M. Deslongchamps. But of course I differ from Dr. Dawson when he regards his restorations as representing an Equisetaceous type of plant distinct from *Calamodendron*.

During this investigation I have been forcibly impressed with the almost universal occurrence, within the interiors of other plants, of the cylindrical rootlets of *Stigmaria*; they appear to have penetrated everything that was penetrable. They have forced their way most abundantly into the interior of the lax piths of *Calamodendra*, *Lepidodendra*, and *Dadoxylons*, often making the interpretation of sections of these plants difficult to the eye unfamiliar with the aspect of these ubiquitous rootlets. Their penetrating tendency has culminated in one of Mr. Butterworth's specimens, in which one rootlet has forced its way

into the interior of another rootlet which only happened to be a size larger than itself.

EXPLANATION OF PLATES I.-V.

1. Specimen of Calamite from a Coal-measure Sandstone-Quarry near Oldham: *a*, lower end of the pith, consisting of seven or eight joints; *b*, two verticils of medullary prolongations, or "*verticillate medullary radii*," penetrating the ligneous zone *c*; *d*, single joint of a Calamite, enclosing the above; *e*, supposed bark, replaced by sandstone.
2. Exterior of specimen of Calamite in ironstone, as it existed before being cut up into microscopic sections: *a*, internodes; *b*, nodes; *c*, projecting wedges of reticulated vessels; *d*, intermediate tracts of fusiform cells, or prosenchyma; *f*, extremities of "*verticillate medullary radii*."
3. Transverse section through the centre of an internode: *a*, pith; *c*, *c*, two vascular laminae; *c'*, *c'*, inner margins of the same laminae, corresponding to longitudinal grooves of Calamite; *d*, a prosenchymatous lamina.
4. Transverse section of vessels of fig. 3 *c*, more highly magnified.
5. Transverse section of prosenchymatous cells of 3 *d*, more highly magnified: *a*, proper cell-wall; *b*, infiltrated mineral matter.
6. Tangential section of part of a node, and of the internode below, made transversely to the verticillate medullary radii: *c*, *c*, two vascular tracts; *d*, *d*, *d*, portions of three prosenchymatous tracts; *d'*, converging vessels near the base of a prosenchymatous lamina, supplying a lateral branch above the node; *d''*, corresponding part to *d'*, but not giving off a lateral branch; *f*, *f*, *f*, three transversely divided medullary radii.
7. Portion of fig. 6 *c*, more highly magnified: *e*, *e*, medullary rays, divided at a right angle to their course; *g*, *g*, elongated vessels.
8. Portion of prosenchymatous tract, fig. 6 *d*, with the fusiform cells more highly magnified.
9. Vertical section of a vascular tract, made in the plane of a medullary ray: *c*, reticulated vessels; *e*, cells of a medullary ray in their lateral aspect.
10. Vertical oblique section of a node nearly in the plane of one of the medullary radii: *a*, pith; *b*, central internal projection of the node into the pith; *c*, vascular tract above the node; *d*, prosenchymatous tract below the node; *f*, medullary radius.
11. Transverse section of part of fig. 10 *c*, nearly in the plane of *b*, consisting of transversely divided vessels disposed in radiating lines: *i*, *i*, small groups of irregular prosenchymatous cells at each inner angle of the projection.
12. Two vessels of fig. 9 *c*, more highly magnified.

13. Transverse section in the plane of the verticillate medullary radii: *a*, pith; *c, c*, woody wedges; *f, f, f*, medullary radii.
14. Portion of fig. 13, more highly magnified: *a* pith; *c*, extremities of reticulated vessels; *d, d*, a few rows of prosenchymatous cells; *f, f*, two medullary radii.
15. Tangential section of part of a node, close to the pith: *c*, vascular tract below the node; *c', c'*, two similar tracts above the node; *d*, lower extremity of a prosenchymatous tract above the node, with section of the vessels supplying a lateral branch; *d, d*, uppermost portions of two prosenchymatous tracts below the node; *f, f*, two transversely divided medullary radii.
16. Diverging vessels of fig. 15 *c*, more highly magnified: *g, g*, reticulated vessels; *h, h'*, transverse sections of intercalated prosenchymatous cells.
17. Diagram illustrating the apparent direction of the vessels in fig. 10: *a*, pith; *b*, node; *c*, vessels of vascular tract deflected into outward curves, on crossing the node; *d*, prosenchymatous cells; *e*, vessels passing to the surface to supply a branch.

The first of these is the *Quercus agrifolia*, which is the most common of the oaks in the mountains. It is a large tree, with a thick, deeply furrowed bark, and a dense, rounded crown of dark, glossy leaves. The leaves are ovate, with a serrated margin, and a prominent midrib. The fruit is a small, acorn-like nut, with a short, hairy stalk.

The second of these is the *Quercus laevis*, which is a smaller tree, with a more slender trunk and a more open, spreading crown. The leaves are ovate, with a serrated margin, and a prominent midrib. The fruit is a small, acorn-like nut, with a short, hairy stalk. This oak is common in the lower mountains, and is often found in association with the *Quercus agrifolia*.

The third of these is the *Quercus engelmannii*, which is a small tree, with a slender trunk and a rounded crown. The leaves are ovate, with a serrated margin, and a prominent midrib. The fruit is a small, acorn-like nut, with a short, hairy stalk. This oak is common in the lower mountains, and is often found in association with the *Quercus laevis*.

The fourth of these is the *Quercus chrysolepis*, which is a small tree, with a slender trunk and a rounded crown. The leaves are ovate, with a serrated margin, and a prominent midrib. The fruit is a small, acorn-like nut, with a short, hairy stalk. This oak is common in the lower mountains, and is often found in association with the *Quercus engelmannii*.

The fifth of these is the *Quercus dumosa*, which is a small tree, with a slender trunk and a rounded crown. The leaves are ovate, with a serrated margin, and a prominent midrib. The fruit is a small, acorn-like nut, with a short, hairy stalk. This oak is common in the lower mountains, and is often found in association with the *Quercus engelmannii*.

The sixth of these is the *Quercus agrifolia*, which is a large tree, with a thick, deeply furrowed bark, and a dense, rounded crown of dark, glossy leaves. The leaves are ovate, with a serrated margin, and a prominent midrib. The fruit is a small, acorn-like nut, with a short, hairy stalk.

The seventh of these is the *Quercus laevis*, which is a smaller tree, with a more slender trunk and a more open, spreading crown. The leaves are ovate, with a serrated margin, and a prominent midrib. The fruit is a small, acorn-like nut, with a short, hairy stalk.

The eighth of these is the *Quercus engelmannii*, which is a small tree, with a slender trunk and a rounded crown. The leaves are ovate, with a serrated margin, and a prominent midrib. The fruit is a small, acorn-like nut, with a short, hairy stalk.

The ninth of these is the *Quercus chrysolepis*, which is a small tree, with a slender trunk and a rounded crown. The leaves are ovate, with a serrated margin, and a prominent midrib. The fruit is a small, acorn-like nut, with a short, hairy stalk.

The tenth of these is the *Quercus dumosa*, which is a small tree, with a slender trunk and a rounded crown. The leaves are ovate, with a serrated margin, and a prominent midrib. The fruit is a small, acorn-like nut, with a short, hairy stalk.

The eleventh of these is the *Quercus agrifolia*, which is a large tree, with a thick, deeply furrowed bark, and a dense, rounded crown of dark, glossy leaves. The leaves are ovate, with a serrated margin, and a prominent midrib. The fruit is a small, acorn-like nut, with a short, hairy stalk.

The twelfth of these is the *Quercus laevis*, which is a smaller tree, with a more slender trunk and a more open, spreading crown. The leaves are ovate, with a serrated margin, and a prominent midrib. The fruit is a small, acorn-like nut, with a short, hairy stalk.

The thirteenth of these is the *Quercus engelmannii*, which is a small tree, with a slender trunk and a rounded crown. The leaves are ovate, with a serrated margin, and a prominent midrib. The fruit is a small, acorn-like nut, with a short, hairy stalk.

The fourteenth of these is the *Quercus chrysolepis*, which is a small tree, with a slender trunk and a rounded crown. The leaves are ovate, with a serrated margin, and a prominent midrib. The fruit is a small, acorn-like nut, with a short, hairy stalk.

The fifteenth of these is the *Quercus dumosa*, which is a small tree, with a slender trunk and a rounded crown. The leaves are ovate, with a serrated margin, and a prominent midrib. The fruit is a small, acorn-like nut, with a short, hairy stalk.

Fig. 1.

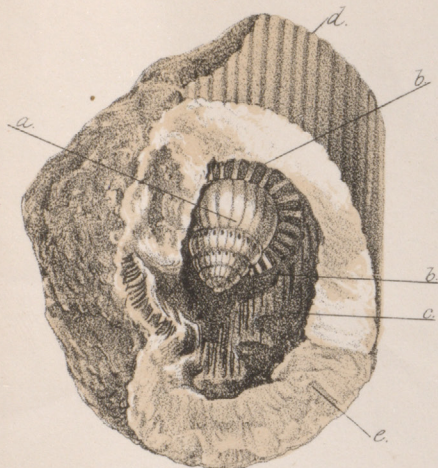


Fig. 2.

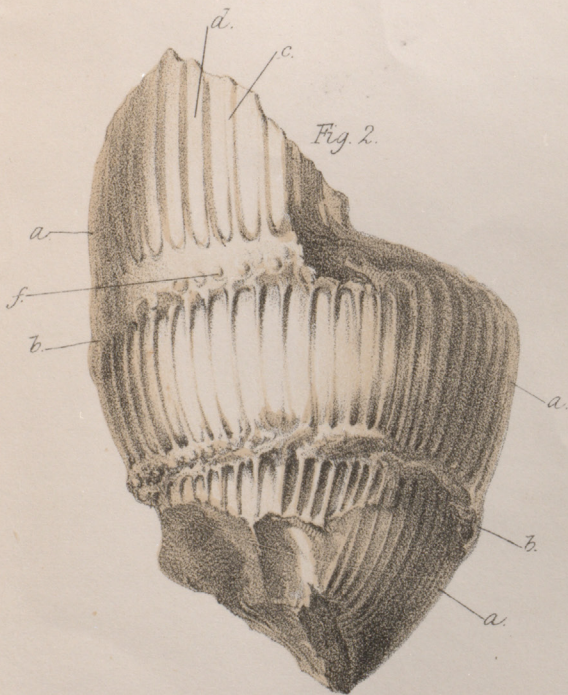


Fig 14.

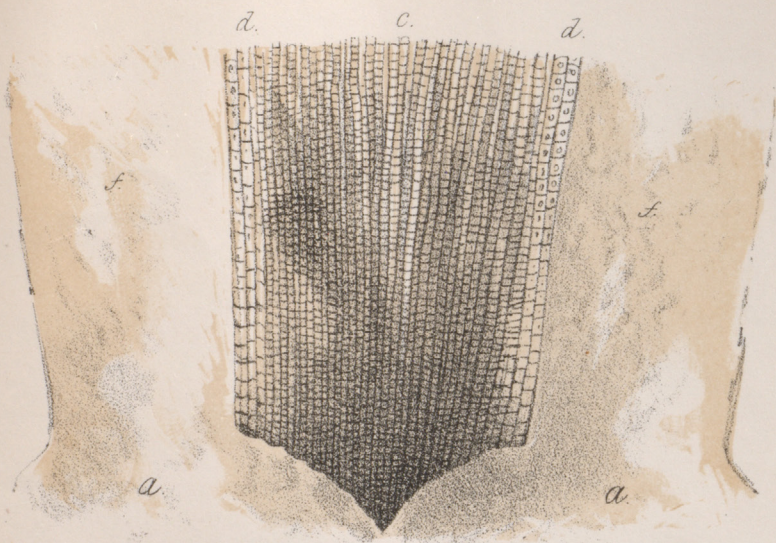


Fig. 3.

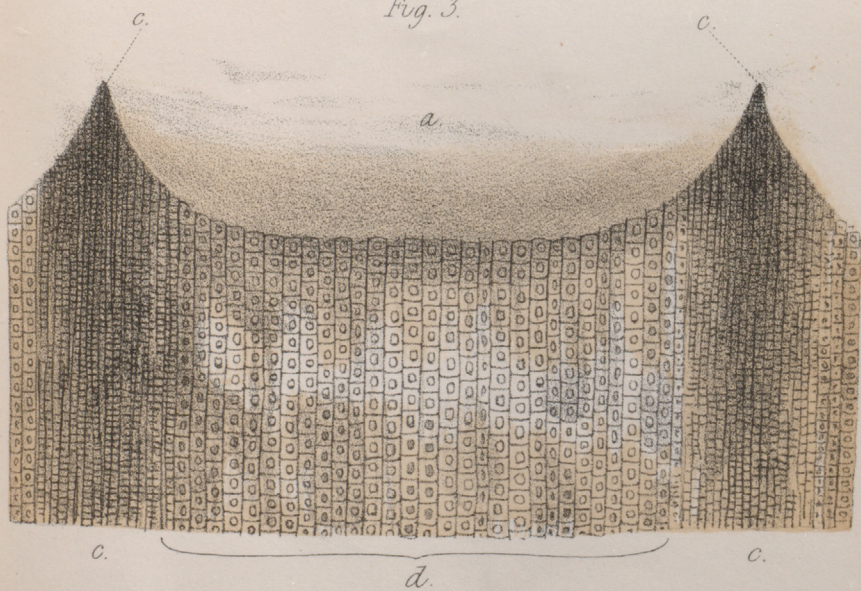


Fig. 6.



Fig. 11.



Fig. 12.

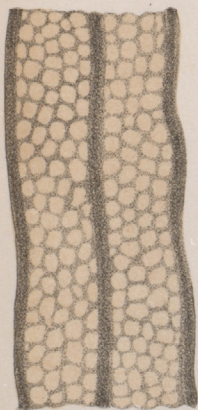


Fig. 9.

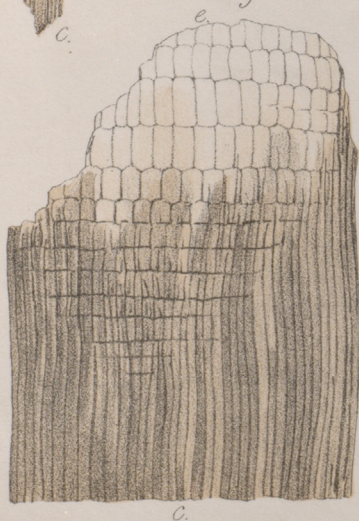


Fig. 10.

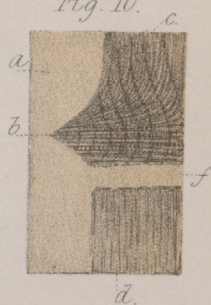


Fig. 13.

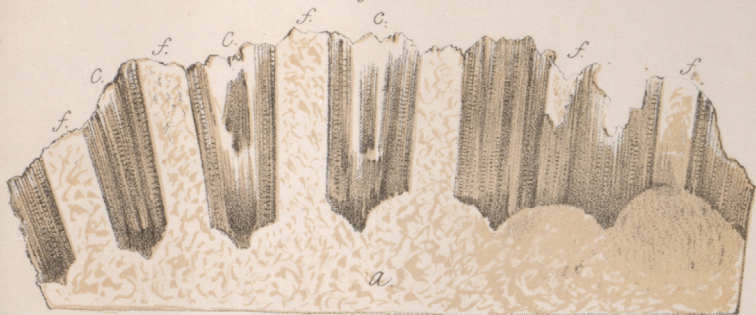


Fig. 15.



Fig. 16.

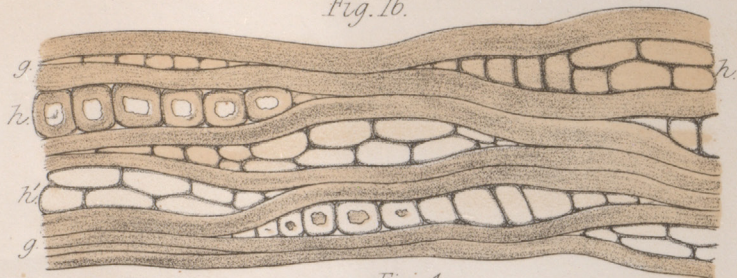


Fig. 17.

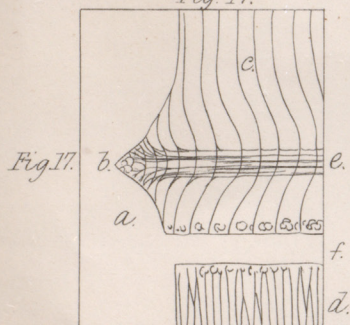


Fig. 4.

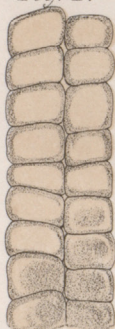


Fig. 5.

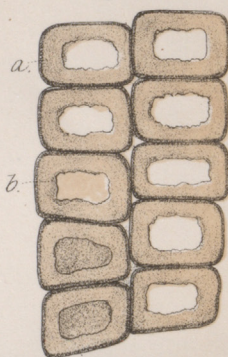


Fig. 8.



Fig. 7.



7



G.R. De Wilde del. lith.

W. Westimp

Plants from the Skiddaw Slates.

[Extracted from the GEOLOGICAL MAGAZINE. Vol. VI. November, 1869.]

ON THE OCCURRENCE OF PLANTS IN THE SKIDDAW SLATES.

By HENRY ALLEYNE NICHOLSON, M.D., D.Sc., M.A., F.G.S., Lecturer on Natural History in the Extra-Academical School of Edinburgh.

(PLATE XVIII.)

THE occurrence of plant-remains in the Silurian and Cambrian rocks is a subject of great interest, but one which has not hitherto been sufficiently investigated. Many supposed plants have been described by Emmons, Hall, Billings, and Dawson, from the older Palæozoic rocks of North America, and little doubt can be entertained of the vegetable nature of some even of the most ancient of these. Many, however, as believed by Professor E. Forbes and Mr. Salter, are certainly referable to the tracks or burrows of marine animals. More recently the Cambrian rocks of Sweden have yielded to the researches of Torell and Linnarsson some remarkable impressions and casts of fossils, which are believed to be of a vegetable nature (GEOL. MAG., September, Vol. VI., p. 393, Plates XI., XII., and XIII.). In Britain there is not, as far as I am aware, any instance of the occurrence of plant-remains in deposits of Lower Silurian age, as to the nature of which all authorities are agreed.¹ The *Oldhamia* of the Cambrian rocks is believed by Mr. Salter to be a plant, but good authorities would place it either amongst the Polyzoa or Hydrozoa. The *Cruziana semiplicata* of the Lingula Flags has often been assigned to the Fucoids, but it is believed by Mr. Salter to be "the filled-up burrow of a marine worm" (Mem. Geol. Survey, vol. iii., p. 248). Long ago Professor McCoy described from the Skiddaw slates (lowest Llandeilo) certain fossils which he believed to be fucoids (Quart. Journ. Geol. Soc., vol. iv., p. 223, and Pal. Foss., pl. i. A). After studying a large number of specimens, however, I have been compelled to come to the conclusion, held by Mr. Salter and Professor Harkness, that these fossils (viz. *Palæochorda major*, *P. minor*, and *Chondrites acutangulus*) are truly referable to the action of marine worms. Within the last few years, however, I have obtained from the Skiddaw Slates several fossils, which certainly do not admit of being explained in this manner, though I would not go so far as to assert that they are unquestionably plants. The age of the deposit in which they occur renders them, at any rate—whatever their true nature may be—of sufficient interest to merit a short description.

Buthotrephis Harknessii, n. sp. (Pl. XVIII., Fig. A). In his Palæontology of New York, Professor Hall describes several species of plants under the generic name *Buthotrephis*, their range in time extending from the Calcareous Sandstone up to the Clinton Group (Upper Silurian). The characters assigned to the genus are as follows:—"Stems sub-cylindric or compressed, branched; branches numerous, divaricating, leaf-like; structure vesicular"? (See Pal. N. York, vol. i., p. 8.) The nature of the fossils described under this head is such as to show clearly that, if not of vegetable origin, they are

¹ With the details of Mr. Hicks's recent discovery of plants in the Cambrian Rocks of St. David's I am not acquainted.

certainly not referable to the operations of Annelides, Molluscs, or any other animals. This is proved by the fact that they are always more or less regularly branched; and also by their not being simple impressions on the sediment, but by their possessing, on the other hand, a true organic structure, differing in colour and grain from the surrounding matrix, and sometimes even exhibiting a carbonaceous texture.

In the upper beds of the Skiddaw Slates, I have found specimens of a fossil apparently belonging to the genus *Buthotrephis*, and bearing considerable resemblance to *B. gracilis*, more especially to the variety *crassa*, described by Hall from the Clinton Group (Op. cit. vol. ii., pl. v. fig. 3). The characters, however, of these fossils are so little definite, and the above-mentioned species is so variable, that I have not thought it safe to include our specimens under it, more especially as they exhibit some curious points which are not present in the American form. The fossil in question shows unequivocal organic structure, consisting of dark, nearly black, cylindrical, regularly branching stems, usually about a line in width, which can not be obtained in relief, as they split right through when the shale is laid open. The best specimen which I have found is broken, and consists of a central stem giving off alternately on both sides long secondary branches, which diverge at angles of from 25° to 60° . The terminations of none of these branches are shown, though one attains a length of nearly three inches; nor is any diminution in their diameter observable. The secondary branches in turn bear, at irregular intervals, on both sides, short tertiary offsets, which taper rapidly to a point, and would seem, therefore, to be of the nature of leaves, rather than the bases of fresh branches, though it is not possible to be quite certain of this.

This singular fossil is unquestionably the remains of some organism, and cannot be referred to the action of marine animals of any kind. Its regular mode of branching demonstrates this beyond a doubt. The proofs of its being a vegetable, though less strong, are, I think, sufficiently weighty, more especially as it is difficult to see what else it could possibly be. If it were a Sponge, a Polyzoon, or a Coelenterate of any kind, it would almost infallibly exhibit some structure by which this could be certainly determined, the nature of the sediment being such that the most delicate details—as shewn by the accompanying Graptolites—would be preserved. It is not, however, siliceous, chitinous, or calcareous, and it is merely of a much coarser grain than the enveloping matrix. As to its place in the vegetable kingdom, it were premature, in the absence of perfect specimens, to offer any decided conjecture, though the mode of branching would not lead us to refer it to the Algæ. Hall, however, thinks that *Buthotrephis* is “doubtless allied to the recent *Fucus*,” and it certainly presents some resemblance to the “fucoids” of the lower Ludlow Rock of the neighbourhood of Ludlow.

Loc.—Upper beds of the Skiddaw Slates, Thornship Beck, near Shap.

Buthotrephis (?) *radiata*, n. sp. (Pl. XVIII. Fig. B.).—This fossil occurs only in conjunction with the preceding, and in exactly the same

state of preservation, so that there is some reason to think that they are different portions of the same organism. From the contiguity of the two in some specimens—though this, of course, may be accidental—I have been led to think it possible that this form may in reality be the whorled leaves of *B. Harknessii*, but I have never seen them in direct connection. Its description, however, as a distinct species must be regarded as simply provisional, and I have placed it in the genus *Buthotrephis* only in view of its probably being a fragment of another form.

B. radiata consists of detached whorls of tapering leaves (?), meeting in a common centre, narrow at their origin, and gradually widening out to terminate in blunt rounded extremities. The size of the whorls varies a good deal, the shape being circular or somewhat elliptical. The number of rays in each whorl varies from ten to twenty-five, their length being from a quarter to more than three-quarters of an inch, and their breadth at the extremities being from one-twentieth of an inch to over a line. The colour of the fossil is nearly black, and its texture, like that of the last, is of a much coarser grain than the enveloping matrix.

It is even more difficult than in the case of *B. Harknessii* to imagine what this can be if not a plant, its form not being that ordinarily assumed by phytoid animals. It seems, however, pretty certain that if its vegetable nature be conceded, it can hardly be referred to the Algæ.

Loc.—Upper beds of the Skiddaw Slates, Thornship Beck, near Shap.

Eophyton (?) *palmatum*, n. sp. (Pl. XVIII., Fig. c.)—Unlike the two preceding forms, this exhibits no distinct organic structure, but presents itself merely as an impression upon the surface of the stone. The texture of the rock is so coarse that nothing further than the shape of the fossil can be stated. It consists of a central stem, about two lines in width, which gives off alternately on both sides fan-shaped expansions, which are narrow at their origin, but widen out rapidly till a breadth of about three-quarters of an inch may be attained. A similar fan-shaped expansion terminates the stem, and all are marked with numerous sub-parallel or slightly diverging ridges.

Having only a single fragmentary specimen, it is not possible to fix accurately the position of this fossil, but it agrees in its longitudinal furrowing with *Eophyton*, and may be placed here in the meanwhile. Its characters are, I think, such that it can hardly be ascribed to the action of marine worms, and it is chiefly for this reason that I have been induced to describe it. It also exhibits a much greater affinity to the Algæ than does either of the previously described forms.

Loc.—Lower beds of the Skiddaw Slates, Barff, near Keswick.

Chondrites (?) (Pl. XVIII., Fig. d.)—Besides the above I possess a specimen from the Skiddaw Slates which is, probably, referable to the genus *Chondrites*. I do not describe it, however, as it possibly may belong to the *Graptolitiæ*, and its state of preservation is such that this point can not be decided. It consists of a branching and re-branching frond, the branches of which have a uniform width of little less

than a line, and terminate in rounded extremities. The branches are flexuous, and are given off alternately in a sub-dichotomous manner. The surface of the specimen is so much discoloured with iron that no details of structure can be made out.

Though larger and less branched, this fossil is not unlike the *Chondrites verisimilis* of the Ludlow Rocks of the Pentland Hills, which Mr. Salter fully admits to be a true furoid (Mem. Geol. Survey of Scotland, No. 31, p. 134). As many branched Graptolites, however, occur in the Skiddaw Slates, and as this exhibits no structure, it is safest to leave its position an open question.

Loc.—Lower beds of the Skiddaw Slates, Rake Beck, near Melmerby.

In addition to the above-described obscure but interesting fossils, the Skiddaw Slates yield numerous specimens which might be referred to the genus *Paleophycus* of Hall. I should, however, be certainly disposed to think that most, if not all, the fossils referred by Hall and Billings to this genus are truly of the nature of worm-tracks and Annelide-burrows.

Having recently obtained several new forms from the Skiddaw Slates, I may conclude with a list of the fossils known to me as occurring in this formation.

LIST OF FOSSILS FROM THE SKIDDAW SLATES.

CRUSTACEA.	<i>Didymograpsus bifidus</i> , Hall.
<i>Ægolina binodosa</i> , Salt.	" <i>fasciculatus</i> , Nich.
" <i>caliginosa</i> , Salt.	" <i>geminus</i> , His.
<i>Agnostus Morei</i> , Salt.	" <i>nitidus</i> , Hall.
<i>Caryocaris Wrightii</i> , Salt.	" <i>patulus</i> , Hall.
<i>Leperditia</i> (?)	" <i>serratus</i> , Hall.
<i>Ogygia</i> (?)	" <i>sectans</i> , Hall.
<i>Phacops Nicholsoni</i> , Salt.	" <i>V-fractus</i> , Salt.
<i>Trinucleus Gibbsii</i> , Salt.	<i>Diplograpsus armatus</i> , Nich.
ANNELIDA.	" <i>Hopkinsoni</i> , Nich.
Tracks and burrows (<i>Arenicolites</i> ,	" <i>mucronatus</i> , Hall.
<i>Scolites</i> , and <i>Helminthites</i> .)	" <i>pristiniformis</i> , Hall.
BRACHIOPODA.	" <i>pristis</i> , His.
<i>Discina</i> (?)	<i>Phyllograpsus Anna</i> , Hall.
<i>Lingula brevis</i> , Portl.	" <i>angustifolius</i> , Hall.
HYDROZOA (<i>Graptolitiæ</i>).	" <i>typus</i> , Hall.
<i>Climacograpsus antennarius</i> , Hall.	<i>Pleurograpsus</i> (?) <i>vagans</i> , Nich.
" <i>bicornis</i> , Hall.	<i>Tetragrapsus bryonoides</i> , Hall.
" <i>teretiusculus</i> , His.	" <i>crucifer</i> , Hall.
<i>Dendrograpsus Hallianus</i> , Prout. (?)	" <i>Headi</i> , Hall.
<i>Dichograpsus annulatus</i> , Nich.	" <i>quadribrachiatus</i> , Hall.
" <i>fragilis</i> , Nich.	<i>Trigonograpsus lanceolatus</i> , Nich.
" <i>Logani</i> , Hall.	PLANTÆ (?)
" <i>multiplex</i> , Nich.	<i>Buthotrephis Harknessi</i> , Nich.
" <i>octobrachiatus</i> , Hall.	" (?) <i>radiata</i> , Nich.
" <i>reticulatus</i> , Nich.	<i>Eophyton</i> (?) <i>palmatum</i> , Nich.
<i>Didymograpsus affinis</i> , Nich.	<i>Chondrites</i> (?)

EXPLANATION OF PLATE XVIII.

Fig. A.—*Buthotrephis Harknessi*, sp. nov. nat. size.

Fig. B.—" (?) *radiata*, sp. nov.

Both from the upper beds of the Skiddaw Slates, Thornship Beck, near Shap.

Fig. C.—*Eophyton* (?) *palmatum*, sp. nov. nat. size. From the lower beds of the Skiddaw Slates, Barff, near Keswick.

Fig. D.—*Chondrites* (?), nat. size. From the lower beds of the Skiddaw Slates, Rake Beck, near Melmerby.

Ordinary Meeting, October 19th, 1869.

J. P. JOULE, LL.D., F.R.S., &c.. President, in the Chair.

"On a new form of Calamitean Strobilus," by Professor
W. C. WILLIAMSON, F.R.S.

The author referred to the labours of Mr. Binney and Mr. Carruthers in elucidating the structure of the ordinary type of Calamitean Strobili as affording a standard of comparison, and then proceeded to describe his specimen, which was from the cabinet of Mr. J. Butterworth of High Crompton. It had been a strobilus approaching nearer to Aphylostachys than to Volkmannia, only the three lowermost verticils or joints were preserved. Externally the central axis had been fluted longitudinally like the stems of Calamites. It consisted of a medullary cavity surrounded by a cylinder consisting largely of cellular and prosenchymatous tissues, but also containing, in the prominent external ridges, bundles of *reticulated* vessels. Where these vessels crossed the nodes they described a series of arches of which the concavities were directed towards the medulla, as the author had, in a previous memoir, pointed out to be the case in Calamopituis. Immediately above and below each node the ten external ridges of the axis gradually became more prominent until, at the node, they coalesced, converting the external grooves of the axis into short canals, of which the transverse section was pyriform, and forming a continuous foliar disk, chiefly of cellular tissue, in which were an outer series of twenty smaller pyriform apertures diverging obliquely in pairs from each of the ten larger ones. At the outer angle of each smaller aperture a sporangiophore ascended almost vertically into the cavity of the strobilus, being nearly parallel with the central axis. This sporangiophore supported three or four sporangia grouped around it in a horizontal verticil, the

horizontal section of the entire strobilus consisting of a circle of these smaller sporangial verticils which were so densely packed together as to disturb and mask the regularity of their arrangement. Having given off these sporangiophores with the reproductive organs which they supported, the verticillate foliar disk dipped suddenly downwards and, describing a circular curve, as suddenly outwards and upwards, where it terminated in a verticil of numerous ovato-lanceolate bracts, which enclosed the exterior of the segment to which they belonged and protected the contained sporangia. The author pointed out where the strobilus differed from those described by Binney and Carruthers. In the former each node gave off a horizontal verticil of coalesced bracts, from the centre of which a series of sporangiophores ascended as vertical divergent branches, whilst in the latter there was an alternating arrangement, one node giving off the disk of coalesced bracts, and the next a verticil of sporangiophores springing at right angles *from the central axis*, and having their respective sporangiophores clustered round them in perpendicular verticils. In the author's example the sporangiophores were densely filled with spores. each consisting of an outer cell-wall, an inner cell-membrane or primordial utricle, and cell contents which were often aggregated into a distinctly defined mass in the centre of the cell. There were no traces of elaters connected with the spores.

The author pointed out that in its general aspect and in the type of its structure the strobilus was unmistakably Calamitean—the peculiarity in the position of its sporangiophores being merely generic. Its Calamitean character was further established by the peculiar arched arrangement of the vascular bundles where they cross the nodes—an arrangement which the author has never seen except in Calamites. All the detailed features of the strobilus distinguish it from those described by Binney and Carruthers, and

*See further in
p. 100*

Ordinary Meeting, February 7th, 1871.

E. W. BINNEY, F.R.S., F.G.S., President, in the Chair.

"On the Organisation of an Undescribed Verticillate Strobilus from the Lower Coal Measures of Lancashire," by Professor W. C. WILLIAMSON, F.R.S., &c.

The author directed attention to the existing state of knowledge in reference to internal structure of the organisms long known as *Volkmanniæ*, pointing out the publication, 1st, of one form, by Mr. Binney, subsequently described also by Mr. Carruthers from Mr. Binney's sections, and 2nd, of a second type published by himself. He then proceeded to describe a third type from a specimen discovered in the lower coal measures by Mr. J. Butterworth. This is an oblong strobilus of a lax and slender habit. Its central axis consisted of a bundle of vessels the transverse section of which was a triangle with concave sides and truncated angles. This was surrounded by a broad cylinder of delicate cellular tissue, which again was enveloped by an outer cylinder of prosenchymatous cellular tissue of a dense character. At each node this latter tissue extended outwards as a thick continuous disk, which, at a little distance from the central axis, became subdivided into a peripheral circle of stiff prosenchymatous bracts, the flattened extremities of which stretched upwards and outwards. The upper

part of each undivided disk gave off a large number of slender sporangiophores, many of which ran along the upper surfaces of the disks and bracts to reach the more peripheral sporangia. These sporangia were large and conspicuous—those belonging to each segment being arranged nearly in a plane parallel to the disk—and in four irregular concentric circles. Each sporangium appears to have been attached to the disk by a separate sporangiophore. The spores were very numerous and perfectly orbicular, but their minute organisation, like that of the cells and vessels of the organism, was masked by the mineralisation which it had undergone, being preserved in a highly crystalline carbonate of lime. The author then proceeded to examine the probable affinities of the several forms of strobilus of which the structure is now known. One, which he previously described in the Memoirs of the Society he assigns to Calamites. The other two, viz., that originally figured by Mr. Binney and that now described, he believes to belong to the Annularian forms of vegetation. Two varieties of verticillate foliage have most probably been confounded under the names of Asterophyllites and Annularia—the one being that of the Calamitean plants, the other belonging to the genera of Asterophyllites and Sphenophyllum, and it is to one or the other of these two genera that the strobilus now described, as well as that figured by Mr. Binney, appear to belong. The structure of their central axes is what the author chiefly relies upon in arriving at these conclusions. The name of *Volkmannia Dawsoni* is provisionally proposed for this new strobilus, in honour of the distinguished Principal of M'Gill College at Montreal, and in recognition of his valuable elucidations of Canadian phytology.

"The Tails of Comets, the Solar Corona, and the Aurora, considered as Electric Phenomena, Part II.," by Professor OSBORNE REYNOLDS, M.A.

In the paper which I read before this society, on the 29th of November last, I endeavoured to show that it is probable that these phenomena are a species of that action known as the electric brush taking place in the medium which fills space, be it ether or simply gas, or both. The reasoning I made use of was, essentially *a fortiori*. I pointed to the fact that the electric brush as seen in the Geissler tubes exhibits similar appearances, and that at the times of greatest display on the part of comets and the aurora similar conditions are present, such as a change in the action of the sun, conditions which, to say nothing more, are favourable to electric disturbance. I purposely avoided all attempts to explain how the brush may be produced, feeling that it was sufficient to point to the aurora, which is universally admitted to be electrical, as a proof that such phenomena do exist even if we cannot explain how. This proof, however, is perhaps not quite satisfactory. In order that it may be complete, the other phenomena must be produced in the same way as the aurora, and this, although possible, is not necessary. An assumption which is commonly made respecting the phenomena of the aurora cannot be made with respect to the others. This assumption assigns the two magnetic poles of the earth as the two electrodes between which the electric discharge takes place, which forms the aurora borealis and the australis. If this assumption be maintained, some other explanation must be found for the manner in which electricity may form the tails of comets and the corona. It is quite clear that the

tail of a comet cannot be due to a discharge between two electrodes situated on the comet itself. In the same way, from the position occupied by the corona, it can hardly be due to electricity passing between two electrodes on the sun. In fact, if a comet's tail is electrical, it is due to a discharge of electricity of one kind or another from the comet, which for the time answers to one of the electrodes only. The same may be said of the corona and the sun. If we could observe the aurora from a point distant from the earth, it is very probable that we should find the same to be the case, but whether this would be so or not, an assumption has been made as to the cause and nature of the aurora, which will answer just as well for the corona and comet's tails: it is, that the sun acting by evaporation or otherwise, causes continual electric disturbance between the earth and its atmosphere, the solid earth being negatively charged and the atmosphere positively, and that the aurora is the reunion of these electricities taking place in the atmosphere.

Now as has been already said, this assumption will serve for the comets and the sun as well as for the aurora. If there is a continual electric disturbance between the sun and the medium in which it is placed, so that the sun becomes negatively and the medium positively charged, the reunion of these electricities would form the corona. It must not be supposed that I assume the sun to be a reservoir of electricity which it is continually pouring into space. I consider that the supply of electricity in the sun is kept up by some physical action going on between the sun and the medium of space, whereby the sun becomes negatively charged, and the medium positively.

This may be well illustrated by reference to the common electrical machine: here the motion of the glass against the rubber causes the glass to become positively and the rubber negatively charged; and these electricities do not unite instantly there and then, but remain and accumulate in the respective bodies, until collected and brought together again by the conductor.

Assume then, that the sun is in the position of the rubber, while the ether is in that of the glass: then the corona corresponds to the spark or brush which leaves the conductor. On the same assumption the negative electricity of the comet would be more and more set free by the inductive action of the sun as the comet approached it, and would also be driven off by induction in a direction opposite to that of the sun; and combining with the positive electricity in the ether would form the tail of the comet, in a manner analogous to that in which a negative spark is given off by the lid of the electrophorus.

I think that a rational account may in this way be given of the manner of the electrical action to which I have attributed these phenomena, but I do not consider that the probability of the truth of this electrical hypothesis depends on the value of such an explanation. It is an assumption based on the manner in which it fits into its place, and explains the appearances presented by these beautiful phenomena.

Since this paper was written, my attention has been called to the fact that Mr. Richard Proctor has published views of these phenomena, which somewhat resemble mine. He attributes them in part to electricity and in part to meteors. There is however this fundamental difference between our

views, that he considers the tails of comets as consisting of cometary matter, the difficulty of conceiving which was the origin of these speculations. Moreover, I can conceive no electric discharge between two meteors without a medium between them, and if there is a medium, why is there any necessity for meteors? If, as I see good reason to suppose, gas, when glowing with electricity, reflects or scatters rather than absorbs light of the wave-length which it radiates, that portion of the coronal light, which is polarized and assumed to be reflected, will be accounted for. I think that the recent observations have confirmed the probability of these speculations, inasmuch as they have confirmed the facts on which these speculations were based. There is one point which has not been already noticed, but which seems to me to be of some importance.

If the corona be an electric discharge, the electricity will be continually carrying off some of the elements of the sun into space where they will be deposited and condensed. May not this stream of matter be the cause of the existence of small meteors, and supply the place of those which continually fall into the larger bodies?

"Further Experiments on the Effects of Cold upon Cast Iron," by PETER SPENCE, F.C.S., &c.

In resuming these experiments upon the effects of cold on cast iron, it is not necessary for me to say that I was led to resume them from the apparent undecisiveness of all the experiments brought before the Society some time ago, my own being included in that category, none of them being so free from possible sources of error as to be fitted for finally settling the matter.

In the experiments which I have now to bring before the Society I have limited my aim to a single point, namely, as to whether the reduction of temperature has any, and if so, what effect on cast iron in regard to its powers of resisting

transverse strain either of weight or pressure, and it appears to me that if this point can be satisfactorily settled it will go a long way in settling the other points now in dispute.

As my object, in showing that I have in these experiments eliminated as far as seems possible all sources of error, will be best effected by minute detail, you will excuse anything that may seem trifling. As I was not trying the absolute strength of any sort of cast iron I did not see the force of Mr. Brockbank's objection to my using $\frac{1}{2}$ in. bars instead of the orthodox 1 in. bars. I could obtain $\frac{1}{2}$ in. bars equally good castings, and the machinery for breaking them was more manageable and in my opinion more exact.

Messrs. Rye, Son, and Ogden, of Newton Heath, kindly undertook to make for me 50 bars, each 3 ft. long by $\frac{1}{2}$ in. square, all out of one ladle, and of No. 3 Glengarnock pig and Kirkless Hall common pig—I name these although it does not seem of importance; all I wanted was good, sound, clean, and equal castings; and, knowing the purpose for which they were intended, with great care they turned them out so good that not one of those sent to me was rejected. I now cut each of these bars into three lengths of 1 ft. each, and as they were cut they were thrown into a heap making nearly 150 pieces. They were now taken and all their ends covered with paint, in order that the new fracture might be examined as they were broken. The heap was then brought into the laboratory, having thus had three chances of perfect mixing. A boy of 11 years of age now handed me the pieces singly from the heap, and as I received them I placed them alternately one by one in two lots, until I had got 70 pieces in each lot. One of these was now taken and put into a cask capable of holding 2 cwt. to 3 cwt. of freezing mixture composed of pounded ice and chloride of sodium (which instantly reduces the temperature to zero), and being surrounded with sawdust, they were kept there for nearly 48 hours.

The other 70 were now put into water at 70° Fah, and this was done chiefly in order that they might be broken wet, as those would necessarily be when taken out of the freezing mixture.

The mode of breaking was this:—I put a bar on the suspending wedges, then hooked on the weight scale, and with a number of weights much under the breaking load, raised the loose end of the plank by the screw jack so as to bring the weights to bear. I now added single pounds or 2lb. weights till 15lb. were put on, these were then taken off and a 14lb. weight was placed and single pounds again put on, thus regularly adding till the bar snapped; I then recorded the breaking weight, my assistant meantime putting on another bar. I spent nearly eight hours in breaking these 70 bars, and every one got an equal amount of care.

On opening up the freezing mixture 44 hours after enclosing it, I found it in perfect condition, little solution and no increase of temperature having taken place. The bars were taken into the laboratory in small lots and immersed in another freezing mixture, from which they were withdrawn singly with pliers. Having seized one piece with too firm a grasp I found that my fingers grew white and produced an intense pain as if burned. Some of the freezing mixture was spread on each bar by a spatula while on the machine, so that every one was broken at a temperature within one or two degrees of zero. The mode of breaking was exactly similar to that employed with the other lot, and equal care was given to every bar. This I can affirm, as every one of them was broken by myself, and all entries made by myself.

The results are before you, and to me it was a matter of surprise, when both sets were completed and added up, to find that they almost exactly corroborated my previous experiments, which I do not think were fallacious in their character, but merely defective in their not covering a suffi-

tabulated statement of Mr. Spence's experiments showed a maximum breaking weight of about 5cwt. and a minimum of about 3cwt. The minimum breaking weight was therefore 40 per cent less than the maximum. With experiments showing such an excessive range in the breaking weight of bars, which from the care taken in their production ought presumably to have been homogeneous in quality, it was very unsafe to rely upon a resulting difference of only 3 per cent derived from separately adding the breaking weights of each set together and comparing the gross results. The iron used was obviously of an inferior quality and quite unsuitable for the purpose of reliable experiments.

MICROSCOPICAL AND NATURAL HISTORY SECTION.

January 30th, 1871.

JOSEPH BAXENDELL, F.R.A.S., President of the Section, in
the Chair.

Mr. BOYD DAWKINS, F.R.S., exhibited sections of the calcareous nodules from the Gannister coals of lower coal measures of Oldham, in which the intimate structure of the various forms of carboniferous vegetation were admirably preserved. He also brought before the notice of the Society a series of microscopical sections of coal prepared by Mr. Newton, in which the spores and sporangia present in all bituminous coals, and from which a large percentage of their

bituminous properties was derived, were clearly to be seen. None of these minute bodies have been discovered in anthracite.

Mr. BOYD DAWKINS, F.R.S., then called the attention of the Society to a series of fossils on the table in which the original matter of the hard parts of the living creature had been more or less removed, and replaced by various minerals which happened to be in solution in the matrix in which they were imbedded. Thus the *Trigonia Moretonis* of the Stonesfield slate was proved to be a mere cast in calcite of the space once occupied by the shell of the creature. The calcification of the ligament in *Cypricardia rostrata* and *Cardium Stricklandi* from the great oolite of Enslow Bridge (Oxon), and its identity of structure with the valves, showed also that the whole of the original hard parts had disappeared before their replacement by calcite. The same fact was shown to hold good in the case of the corals, which only show organic structure on the outside of the fossil. In some cases, however, the structure of the outer surface has been carried inwards by the petrifying material, as in a case of *Nuccolites dimidiatus* from the coral rag, in which the ambulacral pores and the shape of the angular plates composing the test were carried inwards to the centre of the calcareous spar which now fills the space occupied by the soft parts. Other specimens showed that the calcareous shell had been replaced by sulphide of iron, phosphate of lime, sulphate of baryta, or by silica. The hard parts of the vertebrata are better preserved in their original condition than fossil shells, from the insolubility of the phosphate of lime in the bones and teeth.

A comparison of the various substances of which fossils are composed leads to the conclusion that very little of the original matter of the hard parts is preserved, and that very generally the fossil is a mere cast of the original, filled with whatever mineral happened to be in solution in the stratum in which it is imbedded. In some cases the cast exhibits the minute structure of the original, as in the case of the Yorkshire hazel nuts in the Oxford Museum, in which the kernels have been converted atom by atom into calcite without the cellular arrangement of the original being disturbed, and without the shell being altered in any degree. The fact that our knowledge of animal life in past time depends principally on mere casts of the hard parts which happened to be imbedded in the strata demonstrates the truth of Mr. Darwin's view that the geological record is very imperfect.

Professor W. C. WILLIAMSON, F.R.S., exhibited some specimens of *Stigmaria*, and indicated their bearing upon views advanced even by the most recent writers on the subject. He demonstrated that the centre of the axis was occupied by a pith of delicate parenchyma, wholly devoid of the vessels described and figured by Goeppert, and which certainly never belonged to the part of the plant in which he figured them. The lenticular spaces long known to exist in the lignous zone surrounding the medulla, Professor Williamson showed to be true medullary rays, occupied by mural cellular tissue prolonged directly from the medullary parenchyma. Besides these, smaller or secondary medullary rays separate many of the individual laminæ of the vascular tissue. He then pointed out the true source of the vascu-

lar bundles, which proceed to the large cylindrical rootlets of the plant. The radiating series of vessels which are immediately vertical to each of the quincunctially disposed lenticular medullary rays are projected downwards for a short distance, like a tongue, into the lenticular spaces. Down to this point, the component vessels are disposed vertically, but they became suddenly deflected outwards, at right angles to their previous course, to reach the rootlets for which they are severally destined. The deflected vessels are very numerous, but the greater part of them disappear in succession, only a limited number finally constituting the bundle occupying the centre of each rootlet.

Professor Williamson pointed out the important bearing which these facts have upon the affinities of the *Sigillaria* of which *Stigmaria* is the root. He showed that not only the true *Lepidodendra*, but also the *Lepidodendroid* stems which Mr. Binney has described under the name of *Sigillaria Vascularis*, never could have belonged to the same plant as these *Stigmarian* roots. In the plants indicated the central or medullary axis is occupied by scalariform vessels intermingled with remarkable forms of scalariform cells, as already shown in the case of *Lepidodendra* by Mr. Carruthers, and which equally characterise the other plants referred to. It appears improbable, being contrary to all known facts, that the aerial stem should have such a structure, whilst in the roots its vascular scalariform tissues were replaced by cellular parenchyma of an altogether different type and character. The conclusion to be drawn from these observations is that we are yet as far as ever from all actual knowledge of the internal organisation of the *Sigillariæ*. For the two principal specimens from which the above conclusions were drawn,

Professor Williamson was indebted to Mr. Whittaker, of Oldham, and for others of a similar kind to Mr. Butterworth, of Shaw.

“On the Cultivation of Madder in Derbyshire,” by JOSEPH SIDEBOTHAM, F.R.A.S.

Several attempts have been made to cultivate madder in England and Ireland, but the records of the experiments are very meagre and unsatisfactory, and one can only judge their want of success from the fact that they are not repeated.

Being desirous of ascertaining the capabilities of our soil and climate for this branch of farming, and having suitable land at our disposal at Strines, Mr. Nevill and I determined to try the experiment, the results of which I have now the honour to lay before you.

In order to make the matter plain to those who do not understand the different qualities of madder, it is necessary to give a few words of explanation.

Madder is the root of *Rubia tinctoria*, by some authorities supposed to be a mere cultivated variety of a plant indigenous to this country, and found wild in many places in the limestone districts on rocks and walls. This plant is cultivated for the purpose of dyeing in many parts of Europe and in India.

Its qualities vary much; that from Holland, called Dutch Madder, will dye red, but not purple, and the colour is not fast; that from Italy, called Naples Madder, dyes good reds and purples, but the colour is also loose; that from Turkey, dyes good reds and purples, and is very fast; from France we get two qualities, called respectively rosés, from their dyeing

beautiful reds and pinks, and Paluds, the latter being a name given because the roots are grown on marshy land. The latter yield, besides the fine reds, also a good purple, nearly allied to that produced by Turkey roots.

For the purpose of the experiment we selected a piece of rich land, near the river, at Strines, a little less than an acre, and having prepared it in the usual manner, we had it sown with seed from fine Palud madder, early in the Spring of 1868. The weather was unusually dry and the ground produced a crop of remarkably fine polygonum aviculare, which almost choked the young madder seedlings. (I am inclined to think the seed of this polygonum were mixed with the madder seed.) In the Autumn the madder plants came into flower, and the roots of some pulled up measured 13 inches in length.

The field was weeded, and the plants came up in the Spring of 1869, very strong and healthy, and so on until August, 1871, when we had them dug up. To produce the best results the roots should have remained another year in the ground, but for the purpose of our experiment this growth was considered sufficient. As to yield, the quantity produced was small, probably owing to the very dry season after sowing; in appearance and size the roots were about equal to fine French roots, but on breaking them, instead of the deep red colour in the best French roots these were orange, or yellow.

The dyeing properties were of a very disappointing nature: out of the dye the colours looked full, but on being cleared with soap they were found to be loose, and precisely in character like Dutch madder, the reds and pinks being weak and loose, and the purple element entirely wanting. From

a single experiment it would be unwise to do more than hazard an opinion, as more extended experiments might lead to other results; but I think it probable that the deficiency of colouring matter in these English madder roots is owing to a deficiency of sun and heat. It would not be easy in this country to select a more likely soil for the purpose than that at Strines, and the seed was obtained from a district where the best quality of French madder is grown.

It is said to be a fact that French seed when sown in Holland does not produce a French quality of roots, but one similar in every way to the usual Dutch madder. This, if correct, would support my opinion.

I have here to illustrate this subject, specimens of the various madders in the root and ground state, also the colours produced by each, and the relative degree of fastness, exhibited by portions of each being subjected to boiling soap.

especially the fact that, whilst in all the latter the vascular structures are scalariform, as in the stems to which they are supposed to belong, in this example the vessels are reticulated. But the only Calamitean example hitherto discovered containing such vessels is that described by the author under the name of *Calamopitus*, to which, or to some near ally of it, he believes the strobilus to have belonged. If this be a correct conclusion, the plant furnishes an instance derived from the carboniferous vegetation of a highly organised axis, exogenous in its growth and furnished with medullary rays, but which nevertheless sustained a cryptogamic strobilus. Such a combination, however, is but a primæval illustration of a combination still existing amongst the living *Marsileaceæ*, with which *Calamites* present some affinities. The specimen described was found by Mr. Butterworth in one of the lower beds of the Lancashire coal measures.

MICROSCOPICAL AND NATURAL HISTORY SECTION.

October 11th, 1869.

JOHN WATSON, Esq., President of the Section, in the Chair.

The President delivered an address, from which the following are extracts:—

Some of our botanical members occasionally meet together for excursions in pursuit of their favourite study, and it might be of advantage if the microscopical members would do the same. There are many districts which would yield reward in working, and I may mention that I have been very fortunate during the past summer in obtaining a large number of infusoria, many of them scarce and some new to me: these were found in the succession of ponds lying in the fields between Castle Mill and Mobberly, nearly every pool

possessing its own genera and species, differing from the others. The finest kinds were in the ponds containing water lilies, and particularly in two where *Utricularia vulgaris* was abundant. On the stems of this latter plant I found that finest of all the infusoria, *Stephanoceros Eichhornii* in great beauty: a species I had never previously met with in this district; there were also *Floscularia ornata* and *cornuta*, and in addition to abundance of the more common kinds I obtained *Megalotrocha albo-flavicans*, *Scaridium longicaudum*, *Noteus quadricornis*, *Brachionus Polyacanthus*, *Limnias ceratophylli*, &c., whilst among the decayed sedge leaves there were abundance of *Oscillatoria*.

It will interest all naturalists, and especially entomologists and lepidopterists, to hear that there has very lately been received in this country a fine specimen of the magnificent butterfly *Papilio Antimachus*, of which only one specimen was ever before brought to Europe: this Drury received in 1775 from Sierra Leone, and it was figured by him and afterwards by Donovan, from the drawings of Jones, now at Oxford. The insect at the sale of Drury's collection passed into the hands of Mr. Mc Leay, at whose death it went with his collection to the Mc Leay Museum at Sydney, where it is believed to be now. No other specimen has been seen in Europe until a few weeks ago, one came into the possession of my friend Mr. Christopher Ward, of Halifax, from a collection in the Cameroons district. The late Mr. Aspinall Turner, anxious to possess this fine and scarce insect, sent out some years since a good many drawings of it, with offers of five to ten pounds for every one captured, according to condition, and the same course has been equally pursued, in vain, by Mr. Hewitson and others, with various collectors. It is very gratifying to learn that the species is not extinct, and as one specimen has reached Europe after the lapse of nearly a century, we may hope more will be forthcoming. Mr. Ward writes to me that it measures exactly $7\frac{1}{4}$ inches

in the expanse of the upper wings, and $3\frac{7}{8}$ inches in the lower wings, and he mentions that the peculiar narrowing of the upper wings towards their apices is very singular.

The Darwinian theory appears to be making progress among a certain class of naturalists, but its upholders display a disposition to avoid precision of terms, and to enlarge and confuse the meaning of the words they employ rather than scientifically to limit and define them; they use variability and mutability as having one and the same meaning, instead of distinguishing one as referring to subdivision into varieties, and the other as change of specific forms. Just now, as a development of the theory of natural selection, we hear a great deal from some distinguished entomologists about imitation and mimicry, where resemblance would be the more correct word; and these terms cannot be said to be used figuratively because it is argued that some species and genera of butterflies mimic the colourings and markings of others for the sake of protection from enemies, and for other aims and ends. Certainly the words imitation and mimicry imply foregone intention. Now it is probable that no butterfly ever saw its parent or ancestor, its offspring or posterity, and it is an absurd stretch of imagination that its own observation could induce and enable it to change the colouring and appearance of its successors; and if it had such ability and reasoning power it would effect the change for protection from enemies in the larva and not in the imago. We know that Nature loves to repeat her works, and it is common to find resemblances and repetitions through various and distantly allied families of animals, and they are truly connecting links in the chain of creation.

The controversy is still going on between those who affirm and deny the existence of a vital principle of energy or force, and Professor Huxley stands foremost among the latter; very interesting microscopic observations have been made, and ingenious arguments have been deduced from them, but

the grand step from the lifeless to the living protoplasm has not been diminished. Physiologists may perhaps hereafter discover and explain the difference between organic forms living and dead, but at present it is not proved that the phenomena of life can be reconciled with the mere functions of matter.

"On a new form of Calamitean Strobilus," by Professor WILLIAMSON, F.R.S. [This paper was afterwards read at an Ordinary Meeting of the Society, held October 19th, 1869. See page 7.]

Dr. HENRY SIMPSON exhibited specimens of *Statice spathulata*, gathered by himself this autumn on Hilbree Island, Cheshire. He remarked that the locality is the one given in Lyson's "Magna Britannia," but that the plant had not, he believed, been noticed there for many years.

Mr. TAIT sent a portion of the beach from near Alexandria, Egypt, consisting almost entirely of shells. He stated that for miles along the coast the shore was of a similar character.

Mr. JOSEPH SIDEBOTHAM read a paper on "Varieties in Lepidoptera."

The questions as to what constitutes a species? where does a species end, and a variety begin? and whether a species be a natural or merely an artificial division? are amongst the most difficult of solution in the whole range of natural history, and just at this time are very prominently before the scientific world.

With a view to determine the influence which difference of food and light might have in modifying species, the author gives the following as the result of some experiments which he had made.

I procured about 2,500 larvæ of the tiger moth, in a young state. I divided them into six lots, keeping each in

a separate cage, and feeding them differently. One lot was fed on willow, another on butter bur, (*Petasites vulgaris*), another on hawthorn, another on plum, one on dock, and one on nettle, grass, bramble, and various other kinds of food. A considerable proportion of each became perfect insects, and I could detect no difference whatever in the colours, from the food they had lived upon. That is to say, the variations in colour and marking, were not to be traced in any case to the food. I kept several batches of eggs, and reared the larvæ carefully through the winter, and then again divided them, giving each lot a different kind of food. Again the same result. I found that one year the larvæ I had brought from the coast had usually the inferior wings more or less of a yellow shade, instead of the bright scarlet of the Cheshire specimens.

Having for many years continued these experiments without obtaining any marked results, I this year tried another of a different nature. I selected the tortoiseshell butterfly, as one of the least variable species we have, and I procured several broods of young larvæ just emerged from the egg. These I kept in a dark box until I had all ready, and then I divided each brood into three lots, putting one-third into a box in my photographic room which is lighted with orange colored glass, one-third into a box lighted with blue glass, and the ventilators carefully shaded so that only light of a blue colour could reach the larvæ, the remainder were put into an ordinary cage, in the natural light.

The latter fed up and came out into butterflies in the usual time.

Those in the blue light were not healthy, and though every care was taken, at least fifty or sixty died before changing, and a considerable number changed into chrysalides, and then died, those that came out into perfect insects were very much smaller than usual.

Those lighted by orange-coloured glass fed up very well, but many of the two first lots had come out before one of them changed into chrysalis; scarcely one of them died, and I examined each one before I allowed it to fly, to see

what effect had been produced. I retained a few specimens of each lot to exhibit this evening, and now proceed to describe the difference.

Those reared in the blue light differ from the ordinary form in being on an average much smaller; the orange brown is lighter in shade, and the yellow and orange run into each other, instead of being distinct and separate.

Those reared in the non-actinic, or yellow light, are also smaller, the orange brown is replaced by a salmon colour, the venation more strongly marked, and the blue dashes at the edge of the wings in the usual form, are in these of a dull slaty colour. A series of specimens of these side by side, with those reared in ordinary light, are here for exhibition.

One evening I found about 60 butterflies out of chrysalis, of those in the photographic room, and taking each one carefully I examined them all and allowed them to fly; shortly afterwards I found the whole of them had settled against the wall of the house, and presented a most remarkable appearance, they remained there more than half-an-hour, the western sun was shining against the wall, and it is not unlikely when being suddenly brought from the red light, where they had spent all their lives, to the bright daylight, they have been so dazzled as to act in this peculiar manner.

The results of this experiment do not show any very startling change in colour, such as one would have expected from the known effects of light on plants and from the occasional occurrence of very much more strange varieties, one now and then meets with, which cannot have been subject to such severe treatment; still, when we consider that even this difference is caused in one generation, and in the course of a month, it is a very suggestive fact, and leads one to think that light has certainly as much or more effect on the colours of Lepidoptera, than the difference of food, and might in a long series of generations lead to very material changes in both form and colour, and perhaps considerably modify our ideas of what constitutes a species.

Ordinary Meeting, January 25th, 1870.

J. P. JOULE, LL.D., F.R.S., &c., President, in the Chair.

"On Organic Matter in the Air," by Dr. R. ANGUS SMITH, F.R.S. &c.

I have worked and written so constantly on impurities in air and water, that last year I was told by a periodical of high position that I was quite regardless of the impression made on timid persons, and I began to compare myself to a collector of "varieties," who is often obliged to bring up his curiosities every five years. When I read of the new experiment by Professor Tyndall, showing to the naked eye the numberless bodies in the air, I was abundantly gratified, as I obtain them only by a laborious although simple process. When however Dr. Tyndall began to show the character of these bodies it "smote the chord of self," as I imagined that I had long ago proved that not only organic and inorganic, but organised forms exist in the atmosphere. Neither do I claim this as my original idea, looking rather to the fulness of proof and quantitative results as mine. I think therefore I may remind my friends of some of my work, as I find that they forget, and even I forget the exact words used by myself, and must read up.

But as people don't read much on a subject, I will begin at the end. I have been for two years attempting to measure the amount of putrescible matter in the air of the towns and country places, and I have succeeded to a considerable extent. I also measure the amount that has putrefied and left its remains in the air—the sewage of the atmosphere. Some of my results are published; I have promised some very soon, and some have been ready for printing, under the head of *Chemical Climatology*. The proof of organic matter is old. I seek the quantity in various towns and parts of towns.

I shall not here give a history of the enquiries. So many people claim to have something to say in the matter, that I might amuse myself, if not the public, by a long account. At present I profess to keep almost entirely to my own work. The knowledge of organic matter in the air has never been absent entirely from men's minds in historic times; but the words of Bishop Berkeley are so clear that I prefer to quote them. Besides he is far enough back for the purpose. He says in *Siris* (par. 140):—

“Nothing ferments, vegetates, or putrefies without air, which operates with all the virtues of the bodies included in it, that is, of all nature. * * * The air, therefore, is an active mass of numberless different principles, the general sources of corruption and generation; on the one hand, dividing, abrading, and carrying off the particles of bodies, that is, corrupting or dissolving them; on the other, producing new ones into being, destroying and bestowing forms without intermission.”

And in paragraph 141 he says:—

“The seeds of things seem to be latent in the air, ready to pair, and produce their kind whenever they light on a proper matrix. The extremely small seeds of ferns, mosses, mushrooms. and some other plants, are concealed and wafted

about in the air, every part whereof seems replete with seeds of one kind or other. The whole atmosphere seems alive. There is everywhere acid to corrode and seed to engender. Iron will rust and mould will grow in all places."

No man has before or after him expressed this truth more completely and beautifully. It is hard to improve it by one word. Still, this age demands more detailed knowledge and exact theory; besides, the work of every few years requires to be done again to suit modern methods, although it must be confessed that there is room for the cynic to say that Bishop Berkeley and all the ancients and moderns might be classed with Topsy who think they have explained all by saying "It grows."

I began to examine the air in 1846, and I brought a short notice before the Chemical Society: a simple mode of obtaining organic matter in the condensed breath on windows is recorded in their transactions. On account of this commencement, which promised favourably, the British Association requested me to report on the subject. My report, published in 1848, was considered to have made advance, and was marked out for special mention by the President of the succeeding year, so that the words were not hidden. I quote a part, "That animals constantly give out a quantity of solid organic matter from the lungs, may readily be proved by breathing through a tube into a bottle, when the liquid or condensed breath will be collected at the bottom of the bottle; or by breathing through a tube into water, when a solution of the same substance will be found in the water. This would scarcely require proof if we consider that breath so frequently has an organic smell."

"If this condensed breath be put on a piece of platinum, or on a piece of white porcelain and burnt, the charcoal which remains and the smell of organic matter will be con-

clusive. If it be allowed to stand for a few days (about a week is enough), it will then show itself more decidedly *by becoming the abode of small animals*. These are rather to be styled animalcules, and very small ones certainly, unless a considerable quantity of liquid be obtained: they may be seen with a good microscope. Animalcules are now generally believed to come from the atmosphere and to deposit themselves on convenient feeding places; that is, they only appear where there is food or materials for their growth, and they prove of course the existence of that continuation of elements necessary for organic life. At the same time their presence is a proof of decomposing matter, as their production is one of the various ways in which organized structure may be broken up."

"I mentioned some time ago that I had got a quantity of organic matter from the windows of a crowded room, and I have since frequently repeated the experiment. This matter condenses on the glass and walls in cold weather, and may be taken up by means of a pipette. If allowed to stand some time it forms a thick, apparently glutinous mass; but when this is examined by a microscope, it is seen to be a closely matted confervoid growth, or in other words, the organic matter is converted into confervæ, as it probably would have been converted into any kind of vegetation that happened to take root. Between the stalks of these confervæ are to be seen a number of greenish globules constantly moving about, various species of Volvox, accompanied also by monads many times smaller. When this happens the scene is certainly lively and the sight beautiful, but before this occurs the odour of perspiration may be distinctly perceived, especially if the vessel containing the liquid be placed in boiling water.

"If air be passed through water a certain amount of this material is obtained, but I have found it difficult to pass a

sufficient quantity through. If it is made to pass rapidly, *absorption does not take place*, and evaporation of the water is the consequence; if it passes slowly, it requires several weeks to pass a hundred cubic feet through a small quantity of water. I continued the experiment for three months, but although I obtained sulphuric acid, chlorine, and a substance resembling impure albumen, I did not get enough to make a complete examination; and indeed this could not be expected, as I found that in that time less than a thousand gallons of air had passed through.

"When this exhalation from animals is condensed on a cold body, it in course of time dries up, and leaves a somewhat gelatinous organic plaster; we often see a substance of this nature on the furniture of dirty houses, and in this case there is always a disagreeable smell perceptible."—*Mems.: Brit. Association, Meeting held in August, 1848.*

I quoted the words used by the President of the Association simply to show that the paper was well known:

"For instance, the causes which in our great cities hasten the death and debase and embitter the life of so many, have at last been forced by chemists and physiologists on the notice of the public. Look at Dr. Smith's report on the air and water of towns, in this volume; and when we think that the victims of the deadly influences which are there revealed are chiefly found among the people whose industry is the foundation of our greatness,—that every year cut off from the life of each of these is so much subtracted from national wealth,—even were all moral sense and religious feeling dead in us, we must confess that the knowledge which is capable of averting them 'is of use.'"

Looking over these words at this distance of time it seems to me scarcely possible to write more clearly, although some of the words I should prefer to see changed. Still the subject was a continued study, and it was my strong desire to measure exactly the amount of organic matter.

Not to detail all the attempts, I may come to the report to the Cattle Plague Commission in 1866, in which I give some general views and allude to the works of others. The following may be quoted :—

“It has often been asked—Will a sewer produce cholera, or plague, or cattle disease? We cannot say so, or that every kind of disease may be produced from such accumulations of organic matter. The great epidemics that have passed over Europe seem always to have come from some extraneous source, to act *as if planted by some seed*, and not to have risen up spontaneously here. Without attempting to examine this matter carefully, the result would seem to be, that whilst the decomposition of organized beings after death produces gases and vapours that are opposed to health, these gases or vapours are incapable of originating, although they may be capable of feeding, some of those diseases, such as cholera or plague, which have been observed at all times to come from a warmer climate. There must, however, be some first origin of these diseases, and we cannot prove that the first origin might not take place in our climate, although it seems probable that it requires a warmer sun and a richer vegetation than is to be found in the north. This, however, is sufficiently made out—that, when these diseases do come amongst us, they take root with most effect in those places where decomposing matter is found. If we were to suppose a seed of disease planted in a rich, fertile soil of decomposing matter, we should give a pretty fair description of the fostering effect of impurity on disease. It would in fact appear as if the putrid matter itself took the disease, and transferred it to the living. There seems to be nothing entirely opposed to this view of the case. The question, however, is and has always been—What is the nature of that substance which may be said to form the seed or germ of the disease? Chemists have been inclined to consider it a substance in

process of decay, as the quotation from Liebig already given shows. Physiologists and microscopists have been more inclined to consider it as an organised substance. When Gay Lussac passed a bubble of air into the juice of grapes, and found that fermentation began at once, it was believed that the oxygen was the prime mover, and that, when once begun, the action did not cease. When, however, Dusch and Schroeder found that flesh did not decompose if the air was previously passed through a good filter of cotton wool, some difficulty was thrown on the subject. It would appear as if oxygen were not the only agent in the atmosphere causing decomposition. The investigations of M. Pasteur, who found the subject in this uncertain condition, have advanced it so far that we may now with certainty reason in the belief that organized substances are really found in great abundance in the atmosphere (in all places), and that they are the cause of some hitherto entirely mysterious phenomena, putrefaction included. His object was first to inquire into the possibility of spontaneous generation, and he found that carefully filtered air allowed no organisms to appear in vegetable solutions. He found that near the usual surface of the ground these organisms were so numerous that whenever a vessel containing vegetable matter fit for their growth was opened for a very short time they were found to enter, that in cellars and damp and quiet places, where there was no air or dust floating about, these organisms were fewer, and that, as he ascended the sides of the Alps and the Jura, they diminished in number. A commission of the French Academy confirmed his results. If we examine previous enquiries into the compounds resulting from the decomposition of organic substances, we shall find nothing which is at all calculated to bring out such an intelligible rational view of the origin of many diseases, and also of some phases of putrefaction. Chemists, when they have examined products of the latter action

have found sulphuretted hydrogen, carburetted hydrogen, hydrogen, carbonic acid, nitrogen, hydrogen, ammonia, acetic acid, lactic acid, butyric acid, and numerous uncertain bodies having no activity, and utterly incapable of producing those prodigious results that are found when that force begins to work which produces plague, small-pox, or black death."

I did not enter on Pasteur's ground,—the action of organisms in producing fermentation.

After these opinions and the detail of many facts one is mentioned which was the culminating point of the enquiry, and has led to a mode of collecting the organic particles of air, which I may call established. This word established is used because the experiment has been done by others. It is given in these few but plain words: "The air of cow-houses and stables is to be recognised as containing more particles than the air of the street in which my laboratory is, and of the room in which I sit, and that it contains minute bodies, *which sometimes move, if not at first, yet after a time, even if the bottle has not been opened in the interval.* There is found in reality a considerable mass of debris with hairs or fine fibres, which even the eye, or at least a good pocket lens, can detect. After making about two dozen trials, we have not been able to obtain it otherwise. Even in the quiet office at the laboratory there seemed some indications."

"I found similar indications in a cowhouse with healthy cows; so I do not pretend to have distinguished the poison of Cattle Plague in these forms; but it is clear that where these exist there may be room for any ferment or fomites of disease; *and I do not doubt that one class is the poison itself in its earliest stage.* It would be interesting to develop it farther."

I do not detail the examination made of the condensed air brought from a cowhouse by Mr. Crookes, nor do I detail

the examination of the cotton through which Mr. Crookes had passed the air, nor the glycerine surfaces exposed to the air of cowhouses, which also was done by Mr. Crookes. My object at present is not to give a history, but a few of the prominent points so far as relates solely to my own part.

These experiments were repeated on air in Manchester. A paper was read on the 30th March, 1868, to the Lit. and Phil. Society, Manchester. Dr. Schunck in the Chair. To quote a part—

“Lately I tried the same plan on a larger scale. A bottle of the capacity of 4·990c.c. was filled with air and shaken with water. The bottle was again filled and shaken with the same water, and this was repeated 500 times, nearly equal to $2\frac{1}{2}$ millions cb.c., or 2·495 litres. As this could not be done in a short time, there was considerable variety of weather, but chiefly dry with a westerly wind. The operation was conducted behind my laboratory, in the neighbourhood of places not very clear, it is true, but from which the wind was blowing to all parts of the town. I did not observe any dust blowing, but if there were dust, it was such as we may be called on to breathe. The liquid was clouded, and the unaided eye could perceive that particles very light were floating. When examined by a microscope the scene was varied in a very high degree—there was evidently organic life. I thought it better to carry the whole to Mr. Dancer, and to leave him to do the rest, as my knowledge of microscopic forms is so trifling compared to his.”

Having for years therefore convinced myself of these results, I took the air washings to Mr. Dancer, of Manchester, whose experience in microscopic objects is so great that I was certain to be corrected if I erred, and if I did not err I should be taught more. His examination is very beautiful, and it shews not only organic substances, but very

many in quality and inconceivably many as to quantity. The whole cannot be quoted, but the following will suffice.

"The water was first examined with a power of 50 diameters only, for the purpose of getting a general knowledge of its contents. Afterwards magnifying powers varying from 120 to 1,600 diameters were employed.

"During the first observations, few living organisms were noticed; but, as it afterwards proved, the germs of plant and animal life (probably in a dormant condition) were present.

"1st. Fungoid Matter.—Spores or sporidiæ appeared in numbers, and, to ascertain as nearly as possible the numerical proportion of these minute bodies in a single drop of the fluid, the contents of the bottle were well shaken, and then one drop was taken up with a pipette; this was spread out by compression to a circle half an inch in diameter. A magnifying power was then employed which gave a field of view of an area exactly 100th of an inch in diameter, and it was found that more than 100 spores were contained in this space; consequently, the average number of spores in a single drop would be 250,000.

"On the third day a number of ciliated zoospores were observed moving freely among the sporidiæ.

"Some of this formed a very interesting object, with a high power, and the greater portion exhibited what is called pitted structure. The larger particles of this had evidently been partially burnt and quite brown in colour, and were from coniferous plants, showing with great distinctness the broad marginal bands surrounding the pits; others had reticulations small in diameter. They reminded me of perforated particles so abundant in some kinds of coal.

"Along with these reticulated objects were fragments of vegetation, resembling in structure hay and straw and hay seeds, and some extremely thin and transparent tissue showing no structure.

"A few hairs of leaves of plants and fibres, similar in appearance to flax, were seen, and as might have been expected in this city, cotton filaments, some white, others coloured, were numerous; red and blue being the predominant colours. A few granules of starch, seen by the aid of the polariscope, and several long elliptical bodies, similar to the pollen of the lily, were noticed. After this dust from the atmosphere had been kept quiet for three or four days, animalculæ made their appearance in considerable numbers, the monads being the most numerous. Amongst these were noticed some comparatively large specimens of *paramecium aurelia*, in company with some very active *rotiferæ*; but after a few days the animal life rapidly decreased, and in twelve days no animalculæ could be detected.

"For the purpose of obtaining a rough approximation of the number of spores or germs of organic matter contained in the fluid received from Dr. Smith, I measured a quantity by the pipette, and found it contained 150 drops of the size used in each examination. Now I have previously stated that in each drop there were about 250,000 of these spores, and as there were 150 drops the sum total reaches the startling number of $37\frac{1}{2}$ millions."

After these examples, the first being twenty-four years earlier than the last, I need not add that my certain knowledge is that particles both organic and inorganic are found in air.

Further, that some of the organic particles are organized.

Lime, soda, sulphates, and chlorides have been mentioned in another paper as being found, coal ash and of course carbon, and to some extent the amount measured. In railway carriages we even breathe rolled plates of metallic iron which are large enough to be seen by the naked eye.

Some of the most difficult particles to remove are those of coal smoke, they are oily or tarry or both. These are instances of organic and not organised particles.

For two years I have been endeavouring to measure with certainty the amount of nitrogen in the organic matter, separating it from the inorganic. Some of the results are in the last "Report of the Proceedings under the Alkali Act," and have been pretty extensively published. Other results are soon to be published.

I have not yet spoken of my work, "On the Air of Mines," where drawings of the particles of solid matter are given (in a long report published by the Mines Commission in 1864), because the air was from exceptional places. Still similar results are got above ground. In the small tubes containing air from the mines and solids I was able to detect very distinctly organic matter and to measure the ammonia.

Still the best proofs are in the sight of actual forms and the moving objects. In finding these with many accessories I consider their existence in the air of such places as were tried proved beyond all doubt, also long ago proved. We now require good microscopists to examine the individual forms and to find if every disease has one peculiar to itself, as Mr. Bailey finds every class of plants has its own peculiar pollen. That is probably the next most prolific field for those who desire something more on the subject.

We must not be panic-stricken because of these forms. Some are hurtful, but it may be that others are required for the maintenance of healthy animal life of the highest order, exactly as in vegetable fermentation. We must purify the air within the limits of natural intention, and be careful that we do not overstep its boundaries.

Professor WILLIAMSON, F.R.S., exhibited some specimens affording additional information in reference to the organisation of Calamites. Through the perseverance of his fellow-labourer Mr. Butterworth, he had now obtained, what he had some time ago expected to do, examples whose struc-

ture was intermediate between that of *Calamodendron* and *Calamopituis*. In the general arrangement of their separate parts these new specimens corresponded most closely with the well known type figured by Mr. Binney; but they differ in two important particulars. All their fibrovascular tissues are of the reticulate type seen in *Calamopituis* and *Dictyoxylon*, with here and there a few scalariform vessels interspersed. The cellular laminae separating the vascular wedges again exhibit remarkable variations even in the same specimen; their cells being sometimes elongated into vertical forms of prosenchyma—at others they are extended transversely, parallel to a tangential section—whilst still more frequently they consist of ordinary parenchyma. In another feature also the specimens exhibit considerable variations. In some the fibro-vascular tissues of the vascular wedges are separated by masses of cellular tissue, not only at the nodes but also at the internodes. These tissues which, viewed physiologically, can only be regarded as modified medullary rays, are so numerous in one example that more than two vertical vessels can rarely be found in contact without the intervention of one of these vertical rows of mural cellular tissue. In some other examples these medullary rays are much more scanty, as if connecting the type under consideration with that figured by Mr. Binney. The verticillate medullary radii of *Calamopituis* are wholly wanting in these new examples. Additional proof is thus afforded that all the three types referred to may be but variations, possibly having no more than specific value, and perhaps not always even that, of the common type of *Calamodendron*: and it thus becomes increasingly demonstrable that in the Lancashire coalfield, whatever may be the case elsewhere, we have no evidence of the existence of an *Equisetiform* type of Calamite distinct from the *Calamodendroid* one.

Professor Williamson further announced the discovery by Mr. Butterworth of a young Calamite in which the cortical

layer is well preserved. This important fact has long been a desideratum in connection with English Palæo-phytology. This investing layer proves to be, as Professor Williamson in his previous memoir on *Calamopitum* had suggested was probably the case, a pareuchyma of somewhat remarkable structure, and of a thickness equal to that of the ligneous zone which it invests. But as the investigation of this new tissue is not yet completed, all further description of it must be reserved for some future occasion.

“On the so-called Molecular Movements of Microscopic Particles,” by Professor WM. STANLEY JEVONS, M.A.

Robert Brown, the celebrated botanist, first pointed out, in the year 1827, that minute particles of unorganized matter suspended in water exhibit movements which may easily be mistaken, and were formerly mistaken, for the movements of living animalcules. This motion is exhibited more or less by all substances which are reduced to a sufficiently fine state of division ($\frac{1}{100000}$ inch in linear magnitude to $\frac{1}{1000000}$), and the phenomenon is familiar to all occupied in microscopic observation. Vague suggestions have been often put forth that the motion is due to heat, to electricity, or to chemical affinity, but I have been able to find few published experiments on the subject, and those not of a conclusive kind.

In investigating this phenomenon, I did not learn much by varying the solid suspended substance. The silicates, indeed, appeared to be generally the most active substances, and the purest quartz crystal when reduced to fine powder oscillated rapidly; but such different substances as charcoal, red phosphorus, antimony, and sulphur were also very active. I cannot affirm that any substance is free from movement, but the metallic oxides, and the earthy salts such as car-

bonate of lime, appeared to me somewhat less active in comparison.

In varying the liquid, however, by dissolving different salts therein, I was soon struck by the fact that the purest distilled water alone gave the movement in the highest perfection. With a few exceptions, soon to be noticed, all acids, alkalis, or salts tended to diminish the movement in a manner wholly independent of their peculiar chemical qualities.

The inquiry was much facilitated by discovering that the microscopic movement is closely connected with the suspension of fine powder in water.* Clay and pounded glass which are most active in the microscope are also capable of remaining long in suspension. All acids, alkalis, or salts which checked the motion under the microscope were found also to have a power which has not been sufficiently noticed, of precipitating suspended matter. At the same time gum arabic, which possesses a most extraordinary power of exciting the molecular movement, is also capable of maintaining powder in suspension, and has long been used for this purpose in the manufacture of ink. The molecular motion does not directly affect the gravity of the particles, but it prevents the particles from aggregating together into larger bodies and thus overcoming the resistance of the liquid.

That the motion is due to electricity I was soon convinced, by the close analogy with the circumstances in which electricity is produced by the hydro-electric machine. Armstrong and Faraday found that pure water in this machine alone produced much electricity, and that almost any salt, acid, or alkali prevented the action by rendering the water a conductor. Ammonia, however, is a remarkable

* I have since found that the microscopist Dujardin noticed this connection. See "*Manuel Complet de l'observateur au Microscope*." Paris, 1843, p. 60.

exception, because it does not render water a good conductor, and does not prevent the hydro-electric machine from giving off electricity. In trying ammonia as an *experimentum crucis*, I found that it did not stop the microscopic movement, and had almost an inappreciable effect in precipitating suspended matter. A solution of 10 per cent. of ammonia would have less effect than $\frac{1}{100}$ per cent. of sulphuric acid. The proof is rendered practically certain by the fact that boracic acid which was also ascertained to be a non-conductor by Faraday, does not precipitate matter from suspension.

It is right to add, however, that in the case of acetic acid there is a discrepancy; Faraday stated that it does not render water a conductor; but I find that in common with the other vegetable acids which I have tried it occasions precipitation. The conducting qualities of the substance have not been determined with sufficient accuracy to render a mistake impossible.

It is probable that silicic acid does not render water a conductor, as I find that silicate of soda tends to increase rather than diminish microscopic movement, and is another remarkable exception to the general precipitating power of soluble substances.

I entertain no doubt that microscopic movement is closely connected with the phenomena of osmose so fully investigated by the late Mr. Graham. The connection is that of action and reaction; for if a liquid is capable of impelling a particle in a given direction, the particle if fixed is capable of impelling the liquid in an opposite direction by an equal force. The earthenware jars used by Graham in many of

his experiments are composed of a substance highly active under the microscope, and the fact that osmose is most shown by very dilute solutions (1 p.c. or less) is entirely in accordance with the electric origin of the phenomenon.

I consider it to be established experimentally that the microscopic movement is due to electric action, and if I may venture to suggest a somewhat speculative explanation of the action I would point to the experiments of M. Wiedemann on electric osmose. It was first observed by Mr. Porret that when the poles of a battery are placed in two portions of water separated by a porous division, not only is some of the water decomposed, but another and far larger portion is impelled towards the negative pole. M. Wiedemann having exactly investigated the phenomenon found that for one part of water decomposed 5,000 parts were transported through the porous septum. This impulsion is greater as the resistance of the liquid is greater, and ceases altogether when sufficient acid or salt is added to render it a good conductor. Every particle which is thrown into a polar condition by the action of water must be capable in a minute degree of exerting a similar force. In ordinary osmose the particles being fixed cause a transportation of the fluid; in microscopic movement, on the other hand, the particle is free to move, and the reaction of the liquid probably produces those movements which are visible in the microscope.

Although I have chiefly confined my attention to inorganic substances, I have also found that all organic solid particles which are sufficiently small exhibit the movements in a high degree. Albumen, dextrin, grape or cane sugar,

starch solution, alcohol, &c., seem to have little or no power of destroying the motion; and the extraordinary properties of gum arabic have been noticed. I think it not unlikely that when these phenomena are fully investigated they will give strong support to a theory lately put forward by M. Becquerel, that the movements of fluids in animals and plants, which have often been attributed by Graham and others to osmose, are really due to minute electric currents.

Mr. DANCER, F.R.A.S., stated, that the subject which Professor Jevons brought before the meeting, was one to which he had paid attention at intervals for the last thirty years. He had repeated Dr. Robert Brown's experiments with the majority of the substances named in his paper, and had also experimented with a great number of other substances and different solutions.

The particles approaching a spherical form gave evidence of the greatest activity, with some few exceptions. The activity and duration of the movements vary according to their magnitude and also the solution in which they are suspended. For instance some of the metallic oxides would exhibit the movement for some time, and then gradually get aground on the glass plate, and cease to move. There was some difficulty in reducing metals to particles sufficiently small and regular in form, for the exhibition of the molecular movement; even hardened steel, when rubbed on a very fine hone, appears fibrous, and soft metals such as platinum and copper, like shavings, under a high magnifying power. Those siliceous particles of the hone which have their lines of cleavage favourably situated are frequently detached in thin plates during the act of grinding and form

brilliant objects when viewed by polarised light. Metals reduced in this manner require re-grinding several times before they lose their fibrous character, and become sufficiently minute for successful experiments.

Metallic oxides vary considerably in their form and magnitude, according to the solutions from which they are precipitated. By practice it would be possible in many cases, by their microscopical appearance, to name the solutions from which they had been precipitated. The activity of these, when of favourable size, say from the $\frac{1}{100000}$ th to $\frac{1}{10000}$ th of an inch, is very different, being great in water, solution of gum, sugar, &c., but quite inactive in oil.

Mercury and sulphur when sublimed assume a spherical form, and although these spheres could be obtained from $\frac{1}{10000}$ th to $\frac{1}{100000}$ th of an inch in diameter, they do not exhibit any movement in water. He has sublimed them on to a drop of water, but they refused to sink. Possibly their polished surfaces retained a film of air which floated them. So transparent and perfect in form are the sulphur spheres that they distinctly exhibited the image of a lamp flame at their focal point. Triturated or precipitated sulphur will exhibit active movement in various solutions. As regards the cause of this so-called molecular movement, Mr. Dancer thinks that chemical action will not account for it. Diamond dust, graphite, and other refractory substances, are found to be active in water and solutions of gum. Nor is electricity a satisfactory explanation to him. He has found that particles did not show a marked alteration in their movements, when exposed to electrical influence. The results of many experiments point to heat as a probable cause, and although

the peculiar movements of these particles appear like electrical attraction and repulsion, similar movements might be caused by the changes of temperature of the particles, transmitted through the solutions.

"On a General System of Numerically Definite Reasoning," by Professor WILLIAM STANLEY JEVONS, M.A.

The system of numerical reasoning described in this paper arises from the combination of arithmetical or algebraical calculation with logical reasoning. Its purpose is to determine as far as possible the numbers of individual objects which may compose classes or groups of objects under any given logical conditions, the data consisting in those logical conditions and the numbers of individuals in certain other related classes.

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ON THE
STRUCTURE AND AFFINITIES
OF
SIGILLARIA
AND ALLIED GENERA.

BY
W. CARRUTHERS.

[PLATE X.]

THE genus *Sigillaria* is one of the most abundant and important among the plants of the Carboniferous period. But, except that it was a large tree with a fluted and scarred stem, and had immense succulent roots, little is certainly known regarding it. The structure of the root is well known, having frequently formed the subject of investigation. Numerous specimens of stems have been published, as examples of the genus; but with the exception of that described by Brongniart under the name of *Sigillaria elegans*, they belong rather to the genus *Lepidodendron*; and even *S. elegans* does not represent the most characteristic form of the genus. The stem was most probably simple, though in some species it was certainly branched. The foliage in some forms was composed of long linear leaves; and Goldenberg has figured organs of reproduction in the form of small round sporangia, several of which were borne on the somewhat dilated bases of the leaves at the termination of a branch.

The affinities of the genus have chiefly been deduced from the structure of the stem and roots; and in accordance with the views taken by the different interpreters has been the place they have given it. Some, like Corda and Martius, have held it to be a poly-petalous dicotyledon, while, on the other hand, Dr. Hooker, with a little hesitancy, places it among *Lycopodiaceæ* beside *Lepidodendron*. The generally received opinion is somewhat intermediate, that it is a gymnosperm belonging to an extinct type. Brongniart first enunciated this view; and it has been subsequently maintained by Göppert, Unger, &c., and recently by Dawson in an important and elaborate paper on the Coal Formation of Nova Scotia, published in the Journal of this Society in 1866, and two years later in his 'Acadian Geology.'

I propose to investigate shortly the grounds upon which these eminent palæontologists have given this position to the genus, and how far their interpretations agree with the actual structure of the plant.

I shall first consider the structure of the root, the relation of which to the stem has been established beyond question. The investigations of Mr. Binney on the external form and of Prof. King and Dr. Hooker on the internal structure make it unnecessary that I should describe at any length the root so well known by the name of *Stigmara*. The general structure may be given in a few words. It was a thick root having a medulla of considerable size, surrounded by a cylinder of scalariform vessels; and this again was invested by a large mass of cortical parenchyma. From numerous pits on the outer surface of this cortical layer proceeded the long cellular rootlets, each furnished with a small bundle of firm scalariform vessels that had its origin in the vascular cylinder. In the arrangement of the parts, and in the general aspect of a transverse section of the stem, it agrees with the structure of the stems of *Cycadææ*, and of the fleshy *Euphorbiaceæ* and *Cactææ*. It is unnecessary to say that

mere analogical resemblances give no assistance in determining systematic position, but rather tend to lead astray, as they have done in the genus in question. There is one point in which the fossil differs from the living plants, which must at once, if it can be established, separate them widely in systematic position. I refer to the absence of medullary rays in the vascular cylinder of *Stigmara*. This cylinder is composed entirely of scalariform tissue pierced only by meshes for the passage from the inner surface of the cylinder of the vascular bundles that supply the rootlets.

It is important to remember that medullary rays are composed entirely of muriform cellular tissue, and keep up the connexion between the internal and external cellular structures—the pith and bark. Medullary rays are confined to and characteristic of exogenous stems. They break up the wood into innumerable fine meshes. But, besides these, there are in exogenous stems other and larger meshes for the passage outwards of the vascular bundles which supply the axial appendages—the leaves and branches. In some stems, as in *Phytocrene*, *Tupa*, *Cycas*, *Euphorbia*, *Cactus*, &c., from the size of the vascular bundles these meshes are very large; but in ordinary trees those formed by the leaves early disappear, because, the leaves being deciduous and produced only on the younger portions of the tree, the vascular bundles supplying them are not continued through the whole woody cylinder. It is of the utmost importance to notice these two sets of horizontal radiating structures in the dicotyledonous stem—the one, entirely cellular, being the medullary ray, the other, vascular, being the vessels of the axial organs.

Among recent cryptogams the only plants which have anything like a continuous woody cylinder in their stems are the Ferns. In the *Lycopodiaceæ* and *Equisetaceæ*, as represented among living plants, the vascular bundles of the stem are symmetrically arranged in a large mass of parenchyma, and there is consequently no true separation between the cellular tissue of the medulla and that of the cortical layer. It is however different in many tree ferns, which are composed of a mass of parenchyma traversed by vascular bundles of scalariform tissue, which form a closed circle separating the medulla in the interior from the cortex of the exterior. The tissue of this vascular cylinder is entirely destitute of medullary rays; but it is penetrated by large meshes, through which pass the vascular bundles that supply the fronds and invariably rise from the inner surface of the cylinder.

The trunk of the cryptogam differs from that of the dicotyledon, as regards the points in question, in having its vascular cylinder penetrated by only one kind of horizontal tissue, namely, the vascular bundles belonging to the fronds, while the exogenous stem has, besides, another horizontal tissue of a very different structure and performing a totally different function.

The woody cylinder of *Stigmara* possesses only the vascular horizontal layer; but from not distinguishing aright these two structures, this has been described as a medullary system. Where a medullary ray has been described in addition to the vascular system,

it has arisen from some error of observation. I exclude from this the specimen figured by Cotta under the name of *Stigmaria ficoides*, the vascular tissue of which is composed of Cycadian-like or of dotted vessels traversed by muriform cells of medullary rays; for this is certainly not a specimen of *Stigmaria*.

Brongniart, in his memoir on *Sigillaria elegans*, figures a specimen of *Stigmaria* from the cabinet of Robert Brown, which is now in the collection of the British Museum, and which I have repeatedly and carefully examined. In an enlarged representation of a portion of the cylinder (pl. v. fig. 3) there is shown an axial vascular bundle passing outwards through a mesh between the large wedges of the cylinder. Several open spaces separating the parallel series of vessels on the outer aspect of the cylinder are described as small medullary rays; but the examination of this and of an extensive series of other specimens has convinced me that these are only disruptions of the tissue produced along the line of least resistance from desiccation or some other cause before or during the process of fossilization. Brongniart was unable to detect any remains of structure in these spaces. Such openings are altogether absent in many specimens which I have examined; and in one in the collection of the British Museum they occur on the one half of the specimen and not on the other.

Dr. Hooker, in his paper on the structure of *Stigmaria*, makes no reference to the small cellular medullary rays of Brongniart, which he evidently could not detect in his specimens, and which are not indicated in the least in his beautiful drawings. He, however, describes structures to which he applies the name of medullary rays. "The cylindrical axis," he says, "is divided into elongated wedge-shaped masses, rounded at their posterior or inner extremity by numerous medullary rays of various breadths, some much narrower than the diameter of the tubes, others considerably broader, but none are conspicuous to the naked eye, except towards the outer circumference. The medullary rays, even the narrowest, are traversed by bundles of tubes half the diameter of the largest vessels of the axis, or even less" (p. 434). In the explanation of plate ii, fig. 6, he further says, "The vascular tissue is divided by broad and narrow medullary rays;" and fig. 8 is a "highly magnified view of one of the narrow medullary rays forming a bundle of tubes of less diameter than those forming the wood." The structures described in these extracts are evidently the vascular bundles which belong to the axial appendages. These bundles take their origin in the inner surface of the vascular cylinder, and pass upwards and outwards through a mesh, which increases in size as it reaches the circumference of the cylinder. The vascular bundle did not completely fill the mesh, but was accompanied by a quantity of cellular tissue which is very rarely preserved, the space occupied by it being generally filled with the amorphous material of the matrix in which the specimen is preserved. This parenchyma is composed of roundish cells. In the fern-stem a similar structure exists. The vascular tissue of each frond has a parenchyma associated with it which is continuous with the medulla.

The absence, then, of any true medullary ray excludes the *Stigmara* from the Dicotyledons, and places it beyond doubt among the Cryptogams; and this is further confirmed by the fact that the whole of the vascular tissue is composed of scalariform vessels, which are not known to make up the whole of the vascular tissue of any plants except among the Cryptogamia.

As the internal structure of the root is the same as that of the stem, we ought to find in the latter an absence of true medullary rays, and the existence only of a vascular horizontal system communicating with the axial appendages.

Brongniart's elaborate memoir on *Sigillaria elegans* still supplies the most detailed account of the internal structure of the stem of this genus. It consists of a central cellular axis, or medulla, surrounded by a vascular cylinder; and this, again, is invested by a thick cellular cortical layer, the outer portion of which is composed of fusiform cells of less diameter than those of the inner portion. So far this is precisely what is found in *Stigmara*; but the vascular cylinder is, according to Brongniart, broken up by numerous delicate medullary rays, whose tissue, however, is destroyed. He was unable to detect the least trace of the cells; yet he assumes without any hesitation or doubt that the openings between the radiating lines of the vascular tissue are certain indications of medullary rays, and points out that the difference between *Lepidodendron Harcourtii*, which Lindley and Hutton had described, and his own *Sigillaria elegans* lay entirely in the possession of medullary rays by his plant. When, however, the figures of Brongniart are compared with the numerous specimens which have been discovered since, many of which have been figured, and especially with those published by Binney under the name of *Sigillaria vascularis* (which, however, are species of *Lepidodendron*), it is easy to see that he wrongly interpreted the series of cracks in the small fragment he was examining, just as I have shown he did in Robert Brown's specimen of *Stigmara*. The beautiful longitudinal section cut parallel to the supposed medullary rays (pl. iii. fig. 2) is without any trace of the muriform structure; and it ought to have been seen here if it ever existed. The supposed ends of the medullary rays shown in fig. 203 of plate iv. are much more like the results of desiccation or decay than the sections of rays; and the aspect of the adjoining scalariform vessels does not agree with what would have been produced by a medullary ray upon the vascular tissue forming the margins of the mesh through which it passes.

Brongniart's interpretation of these spaces is repeated by him in his 'Tableau,' and is adopted by all subsequent writers. It forms the real difficulty in the way of Dr. Hooker's referring without hesitation the genus to *Lycopodiaceæ*.

In Dr. Dawson's valuable contribution to our knowledge of the Coal-flora, he describes the medullary rays as existing in *Sigillaria*, in addition to the vascular bundles belonging to the axial appendages; but neither in his letterpress nor his plates can I determine whether this arises from the already adopted diagnosis of the genus, or

is the result of his independent observations. Binney obviously confuses the two kinds of horizontal structures when he speaks throughout his papers of medullary rays composed of "finely barred vessels." He neither figures nor describes any true medullary ray; and it is certain from his drawings that they do not exist. This I have moreover established by the examination of numerous beautifully preserved specimens.

If, then, I am right in believing that the structureless spaces in the vascular cylinder of *Sigillaria elegans* do not represent medullary rays, the structure of the stem exactly agrees with that of the root. This is, moreover, precisely the structure of *Lepidodendron*, *Halonia*, *Ulodendron*, &c., so that I venture to refer, without any doubt, all these genera to the same great group of extinct arborescent *Lycopodiaceae*.

Dr. Dawson describes the vascular cylinder of *Sigillaria* as much more complex than anything I have seen. He says it was double, the inner portion being composed of scalariform, and the outer of discigerous vessels. He has figured a specimen of a stem in which the two kinds of tissue exist together. The important discigerous tissue could not be altogether wanting in Brongniart's specimen if it were really a constituent part of the Sigillarian stem, even though, as Dr. Dawson suggests, it were a young stem or branch*.

* Since writing the above I have had, through the kindness of Sir Charles Lyell, the privilege of examining Mr. Dawson's specimen of the *Sigillaria* figured in plate 17, vol. xv. of the Society's 'Quarterly Journal,' and which has supplied him with the data for his interpretation of the internal structure of the genus. It is unnecessary for me to say that the specimen is accurately figured and described; but it yet appears to me more than doubtful that it belongs to *Sigillaria*. The fact that it was found within the trunk of an erect *Sigillaria* is not sufficient; for we know that hollow *Sigillariae* were often filled with foreign materials. Dr. Dawson has himself obtained from trees at the Joggins, where he found this specimen, the remains of a Lizard. In one of the stems from the volcanic ash-beds at Arran I have determined the existence of some eight or ten distinct stems belonging to several genera. The stem of the *Sigillaria* was erect; and all these contained stems were arranged parallel to the stem itself.

If the argument I have employed above is of any value, the axis described by Dr. Dawson must be foreign to the *Sigillaria* in which it occurred, seeing it contains structures which are not found in any of the numerous specimens of *Stigmaria* that have been examined. The root and stem, being homological structures, are in living plants composed of similar tissues. It is impossible to conceive of another state of things existing. But in Dr. Dawson's axis there are true medullary rays and true coniferous disk-bearing tissue, neither of which occur in *Stigmaria*. I have no doubt that Dr. Dawson's fossil is a true coniferous stem, having a large *Sternbergia*-pith like some other carboniferous *Coniferae*. The scalariform vessels occupy the position of the "medullary sheath." Though true scalariform vessels have not been detected in the *Coniferae*, they occur in the closely allied Gymnospermatus order *Cycadeae*. The single series of disks on the walls of the vessels indicate an affinity between this fossil and the Abietineous Conifers; there are, however, other characters which make it impossible at present to refer this and similar fossils with certainty to any recognized group. I believe Dr. Dawson's fossil to be the same as a stem which has for some time been engaging the attention of Prof. Williamson, for which he has proposed the name *Calamopity*, and a full description of which may be early expected from him.

In conclusion, we may inquire what light the reproductive organs figured by Goldenberg throw upon this question. These consist of several small sporangia borne on the dilated bases of slightly altered leaves. The sporangia in size and form agree exactly with what I have described in *Flemingites*; but their arrangement on the supporting leaves is very different in the two genera. In *Flemingites* they are borne in a double row on the horizontal portion of the leaves which form the cone. I have recently detected similar sporangia associated with a true *Lepidodendroid* plant from a Carboniferous deposit from the South of Brazil. That these sporangia belonged also to the genus *Sigillaria* is very probable, independent of the direct observations of Goldenberg, from the enormous quantity of these capsules which occur in some coals, imparting to them special valuable properties.

Dr. Dawson says he has never found the detached fruits (*Trigonocarpum* and *Rhabdocarpus*) which he associates with *Sigillaria* attached to them; and we need not, therefore, consider what claims they have to be so considered.

The structure of the fruits of *Sigillaria* and allied genera may be characterized as follows:—

Triplosporites, R. Br. Cone with a single sporangium borne on each scale; the sporangia of the upper portion of the cone containing microspores, while those of the lower portion contain macrospores.

Lepidostrobus, Brongn. Cone with a single sporangium on each scale; all the sporangia filled with microspores.

Flemingites, Carr. Cone with a double series of small sporangia on each scale.

Sigillaria, Brongn. Cone with a single patch of small sporangia on the enlarged base of the scale.

It is probable, from the recent observations of Brongniart, that we as yet know the macrospores of only one genus, viz. *Triplosporites*, R. Br.; but this would correspond with the state of our knowledge regarding the similar organs in the living *Lycopodiaceæ*; for of the two principal genera of this Order, the microspores only are known in *Lycopodium*, while both kinds of spores occur in *Selaginella*.

EXPLANATION OF PLATE X.

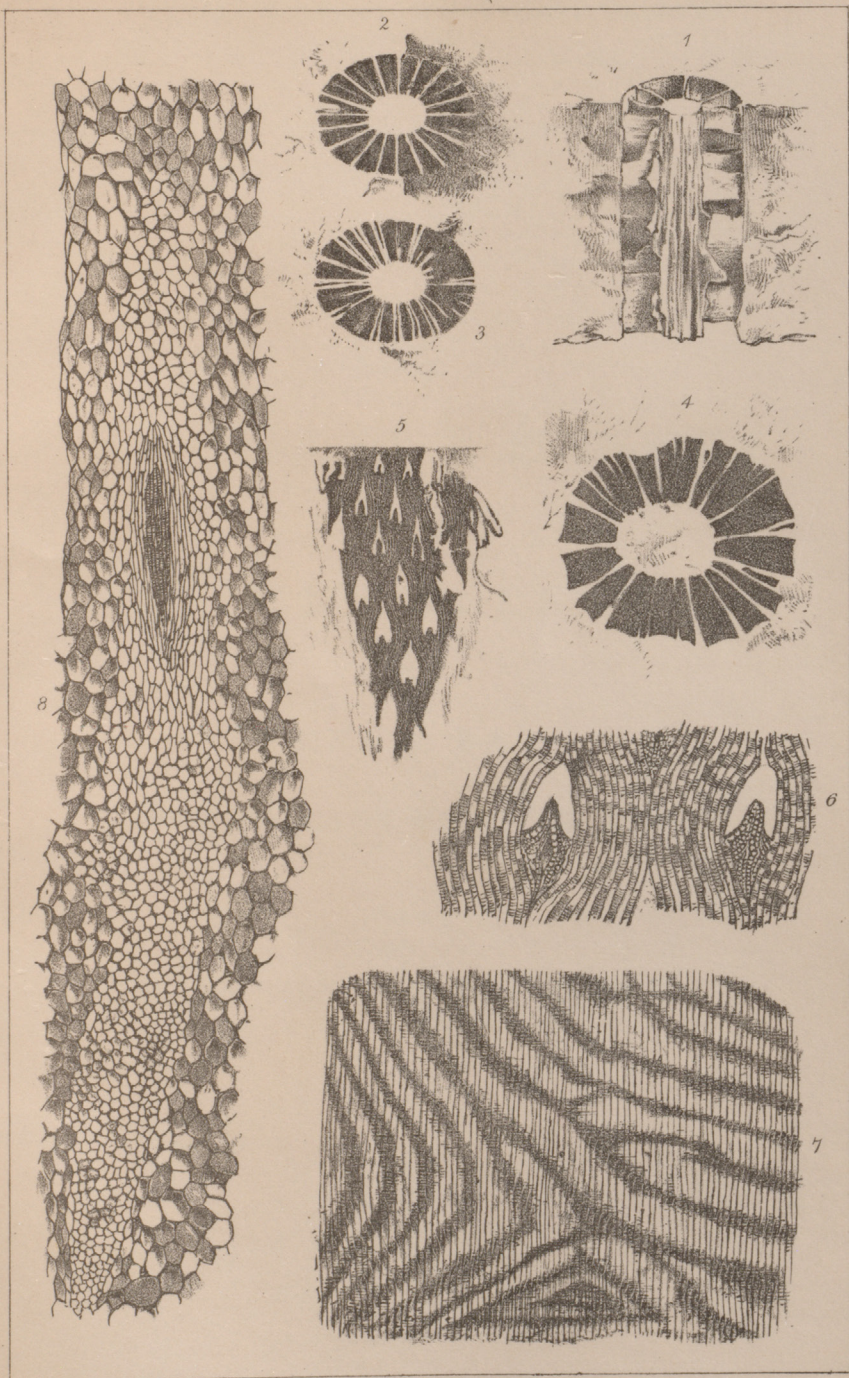
- Figs. 1-3. From a specimen of *Stigmara* in which the whole of the cellular tissue had decayed and the spaces occupied by it had been filled with amorphous clay; thereafter the vascular cylinder itself decayed, exposing the form of the medullary axis and the meshes for the vascular bundles. Fig. 1. Longitudinal section, showing that the meshes proceeded outwards at right angles to the axis. Fig. 2. The casts of the meshes, seen from above. Fig. 3. Ditto, seen from below.
- Figs. 4-7. From a specimen of *Stigmara* in which the vascular tissue is well preserved, but all the cellular structure has been replaced by amorphous material. Fig. 4. Transverse section of the vascular cylinder. Fig. 5. Oblique perpendicular section, gradually sloping outwards from above downwards. The vascular bundle is seen as a ridge at the base of the triangular cavity. This vascular ridge produces the double structure in the cast of the cellular cavity as seen from

below in fig. 3. Fig. 6. The two upper meshes of fig. 5, magnified six times, showing the ends of the vessels passing outwards, and the longitudinal section of the scalariform vessels of the cylinder. Fig. 7. Longitudinal section of a portion of the cylinder, magnified six times, parallel to the meshes, showing no indication of medullary rays.

Fig. 8. A vascular bundle and its accompanying cellular tissue from a section of the original specimen of *Lepidodendron Harcourtii*, Lindl. & Hutt. The large cells surrounding the drawing are the parenchyma of the circumference of the stem. The cellular tissue belonging to the vascular bundle is composed of small cells with very delicate walls. This tissue so readily decayed that I have never seen it in any specimen of *Stigmaria*, or in any of these stems except this *Lepidodendron*.

DISCUSSION.

Prof. MORRIS insisted on the necessity of the student of fossil botany being thoroughly acquainted with modern botany also. It was from specimens discovered many years ago by Mr. Prestwich that the true nature of the *Stigmaria* had been discovered; and he quite agreed with the author in regarding them as cryptogams, and in no way connected with gymnosperms. The abundance of cryptogamic spores in coal was hardly at present appreciated. There were some varieties of coal almost exclusively composed of such spores.



W. G. Smith F. L. S. lith.

W. West imp.

STRUCTURE OF SIGILLARIA

[From the QUARTERLY JOURNAL of the GEOLOGICAL SOCIETY for
August 1870.]

ON THE
STRUCTURE OF A FERN-STEM
FROM THE
LOWER EOCENE
OF
HERNE BAY,
AND ON ITS ALLIES, RECENT AND FOSSIL.

BY
WILLIAM CARRUTHERS, Esq., F.L.S., F.G.S.,
BRITISH MUSEUM.

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ROBERT MURRAY.

[PLATES XXIV. & XXV.]

THE Royal Fern (*Osmunda regalis*, Linn.) is the noblest and most striking of our British ferns. The tuft of fronds under favourable circumstances attains a height of nearly 12 feet, and the erect stem is sometimes more than 2 feet long. The stem is perennial, growing in tufts, formed by the repeated dichotomous division of the terminal bud; the whole is matted together by a large mass of adventitious wiry roots. The different stems are stout and firm, and densely covered with the permanent bases of the petioles. It is found in wet, springy, or boggy places all over Britain, and is indeed generally distributed over the northern temperate zone. With one other genus, *Todea*, it forms a small but well-marked natural group of ferns, the *Osmundaceæ*.

I have determined the existence of *Osmunda regalis* in the Norwich Forest-bed from large specimens collected by the Rev. J. Gunn. It is common in the newer submerged forests, having maintained its ground through all the changes that have taken place.

Three closely allied forms have been found in the later Tertiary strata; the oldest was obtained from a bed at the base of the Miocene period. I have now to add a fourth from the Lower Eocene at Herne Bay.

This species is based upon a portion of a stem in the collection of George Dowker, Esq., F.G.S. It is somewhat unequally weathered and water-worn, one of its sides being rubbed nearer to the centre than the other. The whole of the tissues are replaced by silica, and this in so perfect a manner that the most delicate structures are exquisitely preserved.

Externally the specimen exhibits the roundish petioles, irregularly broken, and marked with a single crescentic vascular bundle. Numerous adventitious roots separate the petioles from each other.

In section the stem is found to have the following structure. Near one side, from the unequal wearing of the specimen, is the slender true stem: this is composed of a white parenchymatous medulla, a narrow scalariform cylinder, and a parenchymatous cortical layer. The parenchyma of the medulla consists of roundish thin-walled cells. The slender vascular cylinder is repeatedly interrupted by the long slender meshes, from the margin of which proceed the vascular bundles that supplied the fronds. These meshes

or slits passed upwards and outwards through the cylinder; and in transverse section they are seen either completely breaking up by a thin film of cellular tissue the continuity of the cylinder, or only penetrating it for a short distance. Such partial penetrations sometimes proceed from the inside and sometimes from the outside of the cylinder, depending upon the part of the particular mesh which has been cut. When the mesh is cut near its origin, the cylinder is complete on its outer margin; while when it is cut through the upper portion, the cylinder is complete on its inner margin. Dr. Ogilvie, in a valuable paper on the vascular and woody tissues of ferns (*Annals and Magazine of Nat. History*, 3rd ser. vol. vi. (1860) p. 320, pl. v.), has somewhat misinterpreted this vascular cylinder in *Osmunda regalis*. He says the cylinder is made up of about eight fasciculi, having the same crescentic section as the vascular bundle in the petiole, and having their concavities all turned inwards. This is figured and described in plate v. fig 1. His error arises from his entertaining the notion that the vascular cylinder is composed of the fasciculi of the petioles, which, when they descend into the stem, branch out and anastomose with those derived from former petioles. This cylinder, however, is formed independently of the food-producing leaves, or at all events in advance of them; and the meshes are really the openings through which the fasciculi pass to the leaves. These meshes do not in any way represent the reticulations caused by the medullary rays in the wood of Dicotyledons. They are homologous with the meshes produced by the tissues which pass through the wood into the foliar or ramal appendages.

The vascular cylinder of the stem is surrounded by a thin layer of pale parenchyma similar to that composing the axis. Dr. Ogilvie calls this a cambium layer; but he overlooks the fact that the vascular bundles in ferns are definite and simultaneous, and that a cambium layer does not exist in this position.

The vascular bundles of the petioles spring from the meshes in the vascular cylinder. At their origin they have the crescentic form which characterizes them throughout their whole course in the petiole and rachis, as well as all the branches in the secondary rachides. Each petiole is composed of its vascular bundle, having the concavity of the crescent looking towards the axis of the stem. This is imbedded in a pale parenchyma, composed of slightly oblong cells; and the whole is surrounded by a cortical layer of smaller but more elongated cells, deeply coloured by the deposit in their interior of the brown-coloured substance so extensively distributed in ferns, and which is said, from its abundance in them, to give a peculiar rusty tint to the vegetation of those districts in which (as in some parts of New Zealand) ferns form a prevailing feature. Near the base the petiole is furnished with a wing, which is composed of white cellular tissue enclosed in a thin epidermis. In addition to the colouring-matter in the cortical layer of the petiole, a few small bundles of elongated cells occur irregularly scattered through the central parenchyma, both in the hollow concavity of the vascular bundle and on

its convex surface. The cells adjacent to the inner concave surface of the vascular bundle have a deposit of colouring-matter in them; but this disappears towards the base of the petiole. I am able to confirm the correctness of Dr. Ogilvie's description of this dark band in the petioles of *Osmunda regalis*; but it is probably not always present, as Prof. Church was not able to detect it in the specimens he examined (Linn. Soc. Journal, Botany, vol. vii. 1864, p. 88). Bundles of coloured cells occur, also, irregularly scattered through the parenchyma of the wings.

The axis gives off in the older portions numerous adventitious roots. These proceed, as in tree ferns, from the interpetiolar spaces, and are not developed from the base of each petiole as figured and described by Duval Jouve in the living plant (Billot's Annotations à la Flore de France, 1855, p. 51, pl. 1. fig. 5 A). In the fossil I have a preparation showing their independent origin; and in the living Royal Fern I have dissected them out, tracing them into the vascular cylinder. They have a different structure from that of the petioles, being more or less circular in transverse section, and composed of a small central vascular bundle imbedded in a very little pale parenchyma, and both surrounded by a cylinder of very dark brown elongated cellular tissue. On issuing from the axis the root pushes through the cellular tissues of the petioles, until it is able to pass upwards between two. It then repeatedly branches; and when it escapes beyond the bases of the petioles the branches become long and wiry, and form a dense covering around the recent stems. This has disappeared from the fossil, because of the rubbing to which it has been subjected; but the branching roots are obvious among the petioles in the least-worn surface.

The singularly perfect preservation of the tissues of this fossil is very remarkable. Not only are all the cells and vessels intact, but even the starch-granules, which abound in the parenchyma of ferns, still fill the cells in which they were originally formed; or rather, I should say, the silica by which they are replaced, and which assumes their form, is there. In the form of the granules, and in the method in which they are packed in the cells, the fossil agrees exactly with the recent species. Many of the cells contain the mycelium threads of a parasitic fungus, which are inarticulate, and probably belong to the genus *Peronospora*, one species of which is too familiar from the injury it has brought on the potato crops. The dead stem of the fossil must have been at once attacked by this parasite; it could never have been desiccated, as the most delicate tissues are perfectly preserved. Buried in the moist clay, the silica must have speedily replaced the organic tissues before the most delicate cells, the mycelium threads, or even the starch-granules were disorganized.

The position of the fossil cannot be doubted. It certainly belongs to *Osmundaceae*, and most probably to the genus *Osmunda*. It would be referred without hesitation to this genus by some workers in fossil botany; but it seems to me most desirable not to refer positively a fossil to a recent genus which has been established upon characters that are not present, and consequently cannot be determined, in the

fossil. No botanist dealing with living plants would venture on such materials to decide on their place, far less to describe them as forming a new species. It is very different with fossils belonging to the animal kingdom, where the portion of the organism preserved is generally that which is employed to a greater or less extent in the classification of recent forms. I must therefore adhere to the system of nomenclature I have hitherto followed, notwithstanding that it has been censured by so distinguished a botanist as Prof. Heer (*Flora Foss. Arct.* p. 84), and consider this a species of *Osmundites*. It is no answer to this method to say that species of plants now living found in quaternary deposits, being so far fossil, ought to receive another name; for if the materials are sufficient to determine with certainty the specific identity of the two plants, of course, on the principle I adopt, the same name must be applied to both. It still seems to me of great importance to be able to distinguish the extinct from the existing species by the name, inasmuch as this distinction conveys also to the student, to some extent, the value of the evidence on which the species has been established.

The fossil has been a larger plant than our recent *Osmunda regalis*, or than a similar stem found in a mass of "Süsswasserquarz" near Schemnitz, figured by Pettko under the name *Asterochlœna schemnitzensis* in Haidinger's *Abhandl.* vol. iii. (1850) p. 163, pl. xx., but afterwards referred by Unger to *Osmundites* (*Denkschr. d. K. K. Akad. d. Wiss.* vol. vi. (1853)). I propose to associate with it the name of George Dowker, Esq., F.G.S., from whom I received the specimen, and to name it *Osmundites Dowkeri*. It was found on the shore at Herne Bay, and could have been obtained only from the Lower Eocene beds there—perhaps from the beds below the London Clay.

A group of fern stems are found in the later Palæozoic and in the earlier Mesozoic strata which are nearly allied to those of *Osmunda*. They have been, unnecessarily, divided into several genera; but as they all agree in having a slender caudex covered by the long ascending and permanent bases of the petioles, and numerous aerial roots, it seems better to unite them under Corda's genus *Chelepteris*. The materials are not sufficient to determine with any thing like precision the position of this group of stems; but in the characters I have just given they agree with the recent *Osmundaceæ*, as well as in having the vascular bundle of their petioles simple. There is at least a fair presumption that this is their position; yet it must be remembered that these characters are not peculiar to this recent tribe, but that they are found also in ferns widely separated from them in a natural classification, as, for instance, in *Dicksonia antarctica*. The genus *Chelepteris*, extended as I propose, would include the following species:—

From the Permian of Russia (Grès cuivreux of Orenbourg):—

Thamnopteris Schlechtendalii, Brongn. *Tabl. Genr. Foss.* p. 36.

Bathyppteris rhomboidea, Eichw. *Leth. Ross.* vol. i. p. 96.

Anomorrhœa Fischeri, Eichw. *Leth. Ross.* vol. i. p. 102.

Chelepteris gracilis, Eichw. *Leth. Ross.* vol. i. p. 98.

From the Lower Trias (Grès bigarré) of France, the following:—

Chelepteris vogesiaca, Schimp. *Traité Pal. Vég.* vol. i. p. 702.

Ch. Voltzii, Schimp. *Tr. Pal. Vég.* vol. i. p. 703.

Ch. micropeltis, Schimp. *Tr. Pal. Vég.* vol. i. p. 703.

Bathypteris Lesangeana, Schimp. & Mong. *Monogr. Pl. Foss. des Vosges*, p. 67.

And from the Keuper, near Würzburg:—

Chelepteris macropeltis, Schenk, in *Von Meyer's Palæontogr.* vol. xi. p. 304.

Bathypteris strongylopeltis, Schenk, in *Verh. Phys. Med. Gesellsch. Würzb.* vol. viii. p. 212.

EXPLANATION OF PLATES XXIV. & XXV.

PLATE XXIV.

Figs. 1-3. *Osmundites Dowkeri*, Carr.

Figs. 1 & 2. Drawings of the outer surfaces of the specimen. Fig. 1 is the surface which has been most rubbed, and exhibits the bases of the petioles near their origin. Fig. 2 represents the less-worn surface, with larger petioles and adventitious roots. The lunate vascular bundle is shown at the ends of some of the petioles. Fig. 3 is a transverse section, showing the position of the axis and of the petioles and roots.

Figs. 4-6. *Osmunda regalis*, Linn.

Fig. 4. Outer surface of the caudex after the adventitious roots have been cut away. Fig. 5. Transverse section, showing the axis, petioles, and roots.

Fig. 6. Transverse section of the axis, showing the meshes in the vascular cylinder. All the figures are of the natural size.

PLATE XXV.

Figs. 1, 3, & 4. *Osmundites Dowkeri*, Carr.

Fig. 1. Section of a portion of the centre of the stem, showing:—*a*, the central cellular tissue; *b*, the vascular cylinder with the meshes through which have passed the vascular bundles to the leaves; *c*, the tissues of two petioles or leaf-stalks; *d*, the dark-coloured parenchyma surrounding the axis; *e*, two adventitious roots. Fig. 3. A few cells, showing the starch granules, and the mycelium of the fungus. Fig. 4. Transverse section of a petiole, showing:—*a*, the boundary of the petiole; *b*, the parenchyma surrounding the vascular axis; and, *c*, the parenchyma of the wing of the petiole.

Figs. 2 & 5. *Osmunda regalis*, Linn.

Fig. 2. Transverse section of part of the axis, showing:—*a*, the central cellular tissue; *b*, the vascular cylinder; *c*, two petioles; *d*, the parenchyma surrounding the axis; *e*, a root springing from the vascular cylinder. Fig. 5. Longitudinal section of a petiole, showing:—*a*, the boundary of the petiole; *b*, the parenchyma; *c*, the scalariform tissue; *d*, the parenchyma separating the two extremities of the vascular bundle; *e*, the parenchyma of the wing of the petiole.

DISCUSSION.

Mr. W. W. SMYTH, in calling on those present for remarks on the paper, commented on the very remarkable manner in which the minutest details of the original plant had become silicified.

Mr. ETHERIDGE mentioned the discovery of fossil fern-stems of somewhat similar character at Bromsgrove.

Prof. RAMSAY suggested the possibility of the fossil having been derived from a bed even higher than the Thanet Sands. He thought the rarity of such delicate structures being perfectly preserved by

silicification not so great as might at first sight appear; for in Antigua and elsewhere vegetable forms had been converted into flint as completely and distinctly.

Mr. WOODWARD cited the hot springs in the Island of St. Michael as converting portions of vegetables still growing into flint. He had heard of the ends of piles being converted into flint in the course of thirty years, but had not yet seen them.

Mr. JENKINS inquired whether the Osmundaceæ from different formations offered any evidence of the climate under which they lived. He thought that where vegetable structures were perfectly preserved in flint, the process of silicification had gone on but slowly; but this fell more within the province of the chemist than the geologist.

Mr. HULKE suggested the possibility of the fern having contained a certain amount of silica while still living.

Prof. MORRIS referred the fossil to the Thanet Sands. He thought that the silica in fossilized coniferous and endogenous wood varied in character, and this might throw some light on the process of conversion. He considered that objects containing phosphate of lime, and those containing carbonate of lime, were subject to different processes of silicification.

Mr. WHITAKER was strongly of opinion that the fossil had been derived from quite the upper part of the Thanet Sands.

Prof. DUNCAN called attention to the process of silicification as exhibited by the Antiguan corals, in which one highly insoluble mineral had been replaced by another almost as insoluble.

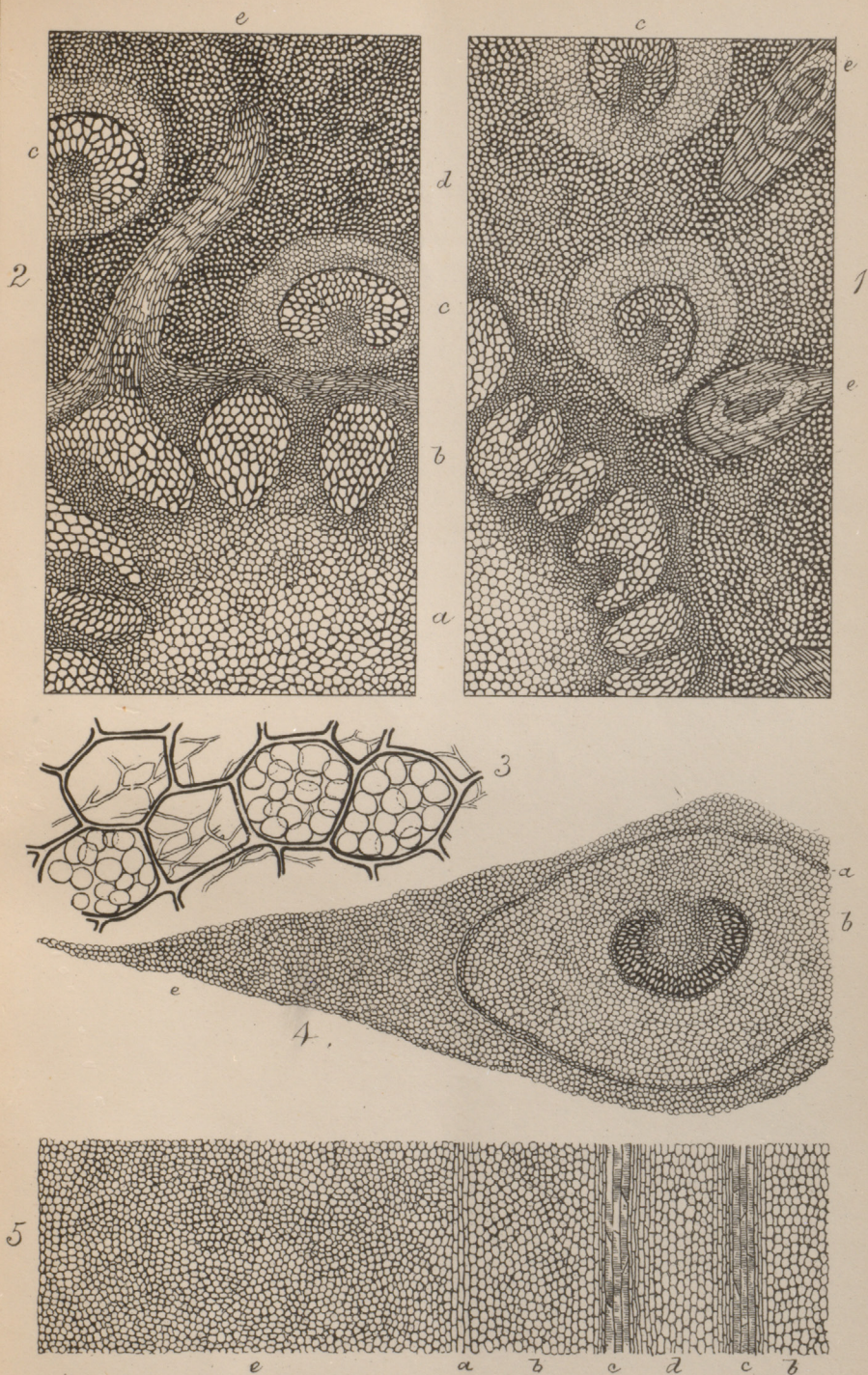
Mr. CARRUTHERS, in reply, did not think that any thing could be predicated as to climate from extinct species; if this were attempted, a similar error to that with regard to the climate under which the fossil Elephants were supposed to have lived, might be repeated. Existing Osmundaceæ contained no silica in their structure. The peculiarity of the fossil under consideration was the preservation of the contents of the cells, even to the starch, which is so readily decomposed. The difficulty of accounting for the replacement of soft vegetable matter by hard mineral silica, seemed to him great.



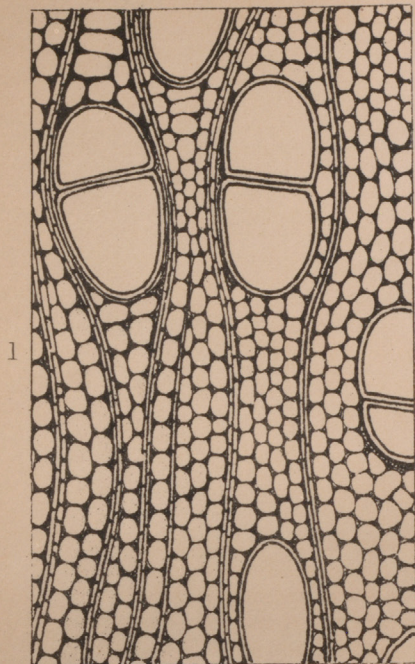
W. G. Smith F.L.S. del^s

W. West imp

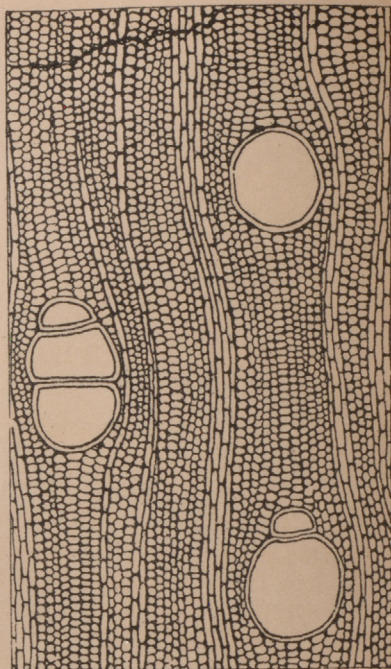
OSMUNDITES AND OSMUNDA.



12



1



3



2



4

W.G. Smith del^o

W. West. Photo-lith

Fossil Wood from Egypt.
1 & 2 *Nicola Owenii*, Carr. 3 & 4 *N. Aegyptiaca*, Ung.

July, 1870.]

ON THE PETRIFIED FOREST NEAR CAIRO.

By W. CARRUTHERS, F.L.S., F.G.S., etc.

(PLATE XIV.)

THE fossil wood which covers the desert to the east of Cairo has long filled the passing traveller on this great Eastern high road with surprise. The immense quantity of what seems to be decaying wood in a region described as a "dreary arid expanse, treeless and almost shrubless, rugged with dark-coloured knolls, and intersected by a few dry rain-channels," excites, by the remarkable contrast of the present with what is apparently the not far distant past, the wonder of the most careless observer. So vividly has this impressed the imagination of travellers that they have without hesitation correlated the fossil stems with the existing vegetation of Egypt. Burckhardt thought they were petrified date-trees, Mr. Holroyd referred them to the Doom-palm, and, to give an air of scientific accuracy to his determination, he adds the systematic name of the species (*Crucifera Thebaica*). Even the accurate "Murray," in his "Handbook for Travellers in Egypt," (1867) speaks of the specimens as palms, and a learned commentator, "A. C. S.," gets into raptures over the remarkable petrified palms which he found *in situ* (p. 156). I must add, however, that Gardiner Wilkinson, the author of the Handbook, refers to branched and thorn-bearing trees, as well as palms; and besides these, he says there are "some jointed stems resembling bamboos, one of which was about 15 feet long, broken at each of the knots. A small one given by me to the British Museum has rather the character of an *Equisetum*." This specimen is a cylindrical fragment of *Nicotia Egyptiaca* (Ung.), 18 inches long and 4 inches in diameter. It has several irregular transverse fissures, filled in with quartz, which has more successfully resisted the weathering than the body of the fossil; hence, the fissures stand out as ridges. A small, stout base of a branch projects for 2 inches from the middle of the specimen. So that this equisetaceous bamboo as well as the palms are really the same as the branched and thorn-bearing trees of Wilkinson—the *Nicotia Egyptiaca* of Unger. Newbold (Quart. Journ. Geol. Soc. vol. iv. p. 352) describes the fossils as resembling in external aspect the present

palm of Egypt, but internally showing the wood arranged in annular concentric layers, as in exogenous stems. A few, he says, exhibited externally longitudinal fibres intersected at intervals from two to three feet asunder by transverse divisions, giving the trunk the appearance of a gigantic calamite, although the internal structure is that of dicotyledonous wood. He submitted his specimens to Robert Brown, who determined that they were dicotyledonous, but not Coniferous. The late Prof. Unger has published a valuable account of his investigation of the woods which he inspected in their native locality (Sitzungsberichte Math.-Naturw. Classe Akad. Vienna, vol. xxxiii. p. 209). He further examined a camel's load of specimens brought home by Kotschy, and determined that they all belonged to one species, to which he had already given the name *Nicolia Egyptiaca* (Endlicher's Genera Plantarum, Suppl. II. p. 102).

When Prof. Owen visited the "Fossil Forest," in the beginning of 1869, he collected a large series of specimens, which, on his return, he kindly placed in my hands for examination. I had a number of microscopic sections made, and had the satisfaction of determining the existence of a second species.

This extensive collection of silicified stems occurs in the Suez desert, about seven miles east by south from Cairo. Newbold says, "The area they cover is about four miles east and west, and three miles and a half north and south. Many of the trunks lie loosely scattered over the surface amid rolled and angular fragments of dark grit, pebbles of chert, jasper, and quartz." They are of various lengths and size. The largest Unger saw were from 50 to 60 feet long. Similar measurements have been given by Newbold¹ and D'Hericourt.² The specimens are frequently deeply fissured transversely, suggesting, as we have seen, the notion of a jointed stem like a bamboo or calamite. The fissures sometimes pass right through, so as to break up a long stem into numerous fragments, a foot or two in length. Neither branches nor roots are found attached to the stems, nor has any trace of bark been detected. Externally they have a striated, fibrous appearance, as if they had been considerably decayed before being silicified. This external appearance, no doubt, suggested the idea of their being fossil *palms*, under which name fragments of them may be met with in almost any provincial museum. The scars of fallen branches are abundant, and always exhibit a considerable hollow at the place, as if the branch had rotted out. The fibrous surface of trunks that have been long exposed has a smooth and polished, almost varnished, appearance, produced by the action of the sand when driven against them by the wind. The wood is generally of a dark reddish-brown colour, and contrasts with the lighter-coloured barren and sandy soil on which it rests or is partially buried. This surface sand rests on a dark-coloured sand and pudding-stone, in which the silicified stems occur, and from which those lying loose on the surface have been washed. This stratum forms the dark-coloured knolls which protrude through the sand, and the stems are seen projecting from

¹ Quart. Journ. Geol. Soc., vol. iv., p. 349.

² Bull. Soc. Geol. France, ser. 2, vol. iii., p. 541.

the weathered sides of these knolls. They lie horizontally in the sandstone. Newbold says a few have a vertical position, rising from 10 to 20 inches above the surface of the sand. Unger considers this bed to be contemporaneous with the Tertiary nummulitic limestones of Egypt. The forests which supplied the wood flourished, he believes, to the south, and the trunks were brought into the flat deserts by running water, which carried with it, also, the sand and mud in which they are now buried. The different density of the woods sorted them in the flood and influenced their transportation, and accounts for the limited number of species, and the remarkable predominance of one of them.

The wood is converted into chalcedony. The tissues are, on the whole, not well preserved, although occasionally specimens occur in which every cell and vessel is clearly defined. Unger detected in some specimens the branching mycelium of a parasitic fungus, penetrating the cavities of the large ducts, to which he gave the name of *Nyctomyces entoxylinus* (Chloris Protogæa, p. 8. tab. I. fig. 7). In none of the large series of microscopic preparations which I have examined (21 from the specimens collected by Prof. Owen, two from the Bryson Collection, and two from that of Robert Brown) have I been able to detect this fungus. In all of them the ducts are filled with transparent chalcedony, which occasionally shows a dark, amorphous and irregular, sometimes branching core, passing down the centre. The chalcedony is more or less filled with minute bodies resembling transverse hexagonal prisms of quartz; but they are thin plates or cavities penetrating the chalcedony in every direction. They have an amorphous centre, and exhibit concentric lines of growth. They do not affect the light differently from the substance in which they are embedded, when examined by the polariscope. Newbold refers to a specimen shown him by M. Linant, at Cairo, which had apparently a somewhat similar structure, but it must have been on a much larger scale, as he does not speak of using any magnifying power in examining it. He says it "had the hollow lined with a white chalcedony-like siliceous substance, full of small cells resembling those of a honey-comb." (loc. cit. p. 353.)

The stems, as determined by Robert Brown, and confirmed by Unger, belong to Angiospermatous dicotyledons, and are made up of the tissues that enter into the composition of such plants. The wood consists of slender prosenchyma, abundantly penetrated by large ducts, which occur singly or arranged, two, three, or even more together. The walls of the ducts are marked with small, regularly arranged oval, or somewhat compressed hexagonal, reticulations. Transverse diaphragms break up the ducts in well preserved specimens into oblong compartments about twice as long as broad. The medullary rays are abundant, and form a considerable proportion of the stem. The concentric layers of wood are not so well defined as one generally finds them in dicotyledonous stems, because of the irregular manner in which the ducts occur throughout the year's growth. In this respect they resemble the walnut rather than the oak.

The histological characters of the stem have been hitherto but little used in systematic botany. A careful examination of numerous specimens, and systematic arrangement of the results, would, no doubt, throw much light on variations in stem-structure, associated with variations in the structures of different plants. But as this has not yet been done, I cannot go beyond R. Brown in saying that, while these stems are dicotyledonous, they are not coniferous.

The genus *Nicolia* was established by Unger in the second supplement to Endlicher's "Genera Plantarum," (p. 102), and was dedicated to William Nicol, who invented the process of slicing and mounting fossil woods for microscopic examination; and who thus supplied the palæontologist with the means of accurate investigation. It may in passing be mentioned in connection with Nicol, that his interesting collection of fossils is now deposited in the British Museum, having formed part of the extensive collection of Alexander Bryson, acquired some two years ago, after the death of that gentleman.

The two species may be thus described.—1. *Nicolia Egyptiaca* (Ung.), Endl. Gen. Pl. Suppl. ii. p. 102, and Sitzungb. Math. Natur. Cl. Akad. Vien. vol. xxxiii. p. 214, pl. 1, figs. 1 and 2, Plate XIV., Figs. 3 and 4. Wood cells in transverse section small, sub-quadrangular, about one-tenth of the diameter of the large ducts. Ducts roundish, singly, or two three and sometimes four, united in linear series. Medullary rays in transverse section, elliptical, with the ends produced, composed in the centre of the ellipse of four cells in thickness, thinning out until the ends are composed of a single cell.

2. *Nicolia Owenii*, sp. nov., Plate XIV., Figs. 1 and 2. Wood cells in transverse section, large, oval, about one-fifth of the diameter of the large ducts. Ducts oval, singly, or two, or three, united in linear series. Medullary rays in transverse section, linear, doubly acuminate, composed of two cells in thickness at their greatest diameter.

EXPLANATION OF PLATE XIV.

Fig. 1. Transverse section of *Nicolia Owenii*, (Carr.) showing the large oval ducts, the large wood cells and the narrow medullary rays.

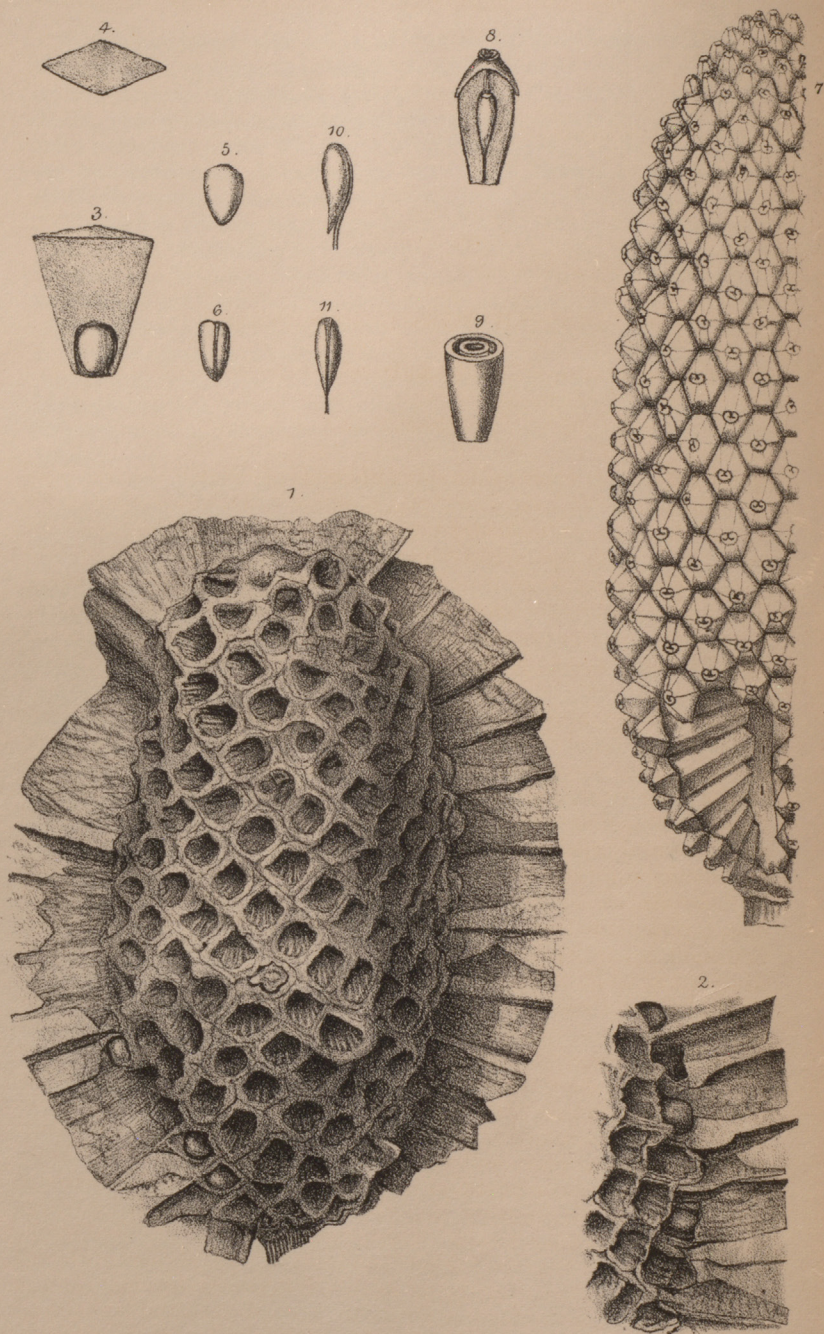
Fig. 2. The same in longitudinal tangential section.

Fig. 3. Transverse section of *Nicolia Egyptiaca*, (Ung.) showing the roundish ducts, small wood cells, and broad medullary rays. The narrow rays are cut through the slender termination of the ellipse.

Fig. 4. The same in longitudinal tangential section.

All the figures are drawn from specimens collected near Cairo by Prof. Owen.

13



A. T. Hollick del et lith

W. West imp

Fossil Pandanaceous Fruit.

BRITISH FOSSIL PANDANÆÆ.

By WM. CARRUTHERS, F.L.S., F.G.S., Botanical Department, British Museum.

(PLATE IX.)

THERE is room for considerable difference of opinion as to the limit of the order *Pandaneæ* or "Screw-pines." However extended it is made there can be no doubt that *Nipa* has closer affinities with the palms than with the screw-pines. I shall therefore exclude the remarkable fruits from the Lower Eocene of Sheppy to which Brongniart applied the name *Pandanocarpum*, altered afterwards by Bowerbank in accordance with the more precise determination of the affinities of the fruits to *Nipadites*, a change in which Brongniart acquiesced.

More nearly allied to *Pandaneæ* are the *Cyclantheæ* with their scaly flowers, polyspermous, many-celled fruits, and fan-shaped leaves, and the *Freycinetiæ* agreeing with *Cyclantheæ* in the structure of their fruit, but with *Pandaneæ* proper in their flowers and foliage. Whether these three closely allied groups form only a single natural order is not of much importance in connection with an enquiry into the fossil *Pandaneæ* of the British rocks, inasmuch as these all, as far as known, belong to the restricted group *Pandaneæ*, represented by the genus *Pandanus* of the younger Linnæus, now split up by Gaudichaud, De Vriese, and Hasskarl, into several divisions considered by them of generic value.

The recent *Pandaneæ*, thus restricted, are arborescent plants, the stem generally branching dichotomously and sending down aerial roots, with long, linear-lanceolate leaves, their margins almost always spiny, and their bases amplexicaul, leaving after decay annular scars, which have suggested the name screw-pine, the latter half of the term referring to the external resemblance of the plants to *Bromeliaceæ* or pine-apples. The flowers are dioecious and naked, and the fruits are composed of numerous one-celled and one-seeded fibrous drupes congregated singly or in compact parcels into large spheroidal or oblong heads. The plants of this group live in the marshy forests of the moist tropical and sub-tropical regions of the old world, their head-quarters being in the Malayan Archipelago, and in Madagascar; some extend as far north as Japan and the Himalayas.

Specimens of foliage referred by Ettingshausen to this order,

although described originally by him under the name *Palæobromelia* have been found in the Tertiary deposits of Austria (Sitzungsber. d. Math.-Nat. classe der K. Akad. der Wissen. Vienna, vol. viii. p. 492). He considers that he has fragments representing five species, which he refers to the genus *Pandanus*.

In England the discovery of fruits has supplied more satisfactory evidence of the former existence of the *Pandanæ*.¹ The first known specimens of a Pandanaceous fruit were figured and described by Prof. Lindley in the second volume of his Fossil Flora (1835), plate 129, under the name of *Strobilites Bucklandi*. Lindley, with great success, educes from his imperfect materials characters which would have led him to place the fossils in *Pandanæ*, had he been obliged to give them a positive position, but he preferred referring them to the provisional genus *Strobilites*, until additional specimens should supply the materials for a more satisfactory determination. Lindley mentions neither the locality nor the age of these fossils, but only that they belonged to Miss Bennet, whose collections, I believe, are now in America. Professor Morris, in his Catalogue of British Fossils, says they were found in the Upper Greensand of Wiltshire.

In 1836 Buckland figured and described a fruit to which, at R. Brown's suggestion, he gave the name *Podocarya*. The fossil was found in the inferior Oolite, at Charmouth, Dorsetshire. It is the size of a large orange, and composed of an indefinite number of cells, each containing, near the surface, a single longish seed, about the size of a grain of rice. The cells were separated from the spadix by long fibrous footstalks, and were surmounted by hexagonal tubercles, in the centre of which could be seen the remains of a stigma. It is to be regretted that Brown did not communicate to Buckland a written description of this hitherto unique fossil fruit, for a looseness of language and defects in knowledge are to be found in the account of the fossil which cannot be charged to him. It is said that "the collection of the seeds into drupes, surrounded by a hard nut, in the fruit of *Pandanus*, forms the essential difference between this genus and *Podocarya*." But the fruits of a large number of species of *Pandanus* consist of separate one-seeded drupes, and if each seed in *Podocarya* be considered as contained in a distinct drupe, there is no essential difference between these species and the fossil. I am inclined, however, to consider it rather as a more complete condition of the union of the ovaries into groups than any form among recent fruits—a condition in which all the drupes were as thoroughly united as they are in each of the phalanges of the fruit of *Eydouxia macrocarpa*, Gaud. In the species with such compound fruits, the fibrous pedicles are much longer than in the other species, forming another point of correspondence with the fossil.

¹ The external markings of the stems found by Mr. W. H. Bensted in the Iguanodon quarry, and named by König *Dracæna Benstedii*, are more like those of a *Pandanus* than a *Dracæna*, but the remains of wood in the interior of these stems suggest doubts as to whether they belong to either the one or the other. I hope to obtain a section of one of the stems and to examine the minute structure of the wood, and I may then be able to determine, with more certainty, their systematic position.

This singular fruit has been lost. Buckland says it was in 1836 in the Oxford Museum, but Professor Philipps has never seen it. Its re-discovery would be a real benefit to science.

Through the kindness of S. Sharp, Esq., F.G.S., I have been able to examine a remarkably perfect specimen of a fruit belonging to the same genus as those described by Lindley, and supplying the material which he desiderated in order to refer his fossils to their positive position. This specimen was found in the Moulton Park Quarries, at Kingsthorpe, near Northampton, in the White Limestone of the Great Oolite. It was presented by A. Markham, Esq., to the Northampton Museum, where it is now deposited. The matrix in which it is preserved is an amorphous cream-coloured limestone which has abounded in molluscan remains, but the shells have been removed, and the spaces they occupied, as well as the other larger cavities in the rock, are lined with or entirely filled up by crystallized calcite. The fruit also is only a cast, in the same material, of the cavity which originally contained it. The fine white mud had insinuated itself into every crack and opening of the fruit, and filled the decayed interior of the upper portion of the drupes. The walls of the seed cavity and the seeds themselves, as well as the outer membrane of the drupes, resisted decay until the matrix was somewhat compacted. These hard portions at length decayed, but the insoluble carbon remained as a black amorphous substance, giving an external coloured coating to the crystallized carbonate of lime, which in the end filled the cavity, preserving in the most perfect manner the form of the fruit, and even some of the minute details as to the relation of the different parts. The hammer of the quarryman that accidentally laid open the fruit has fractured it through the middle of the cells, the portion broken off containing the upper portions of the cells and the apices of the drupes buried in the rock.

The fruit consists of a thick spadix,—not so thick, however, in proportion to the drupes as in *Bryantia butyrophora*, Webb. The drupes leave the spadix at a right angle about one-third from the apex, those above have an ascending and those below a descending direction, increasing as it reaches the fruit stalk, which is seen in the fossil, and shown in the drawing. This arrangement is precisely that of *Sussea conoidea*, Gaud. (Pl. IX. Fig. 7). The drupes are rhomboidal at the base, spreading out laterally towards the apex, where their form is a broad compressed rhomb (Fig. 4) two or three times longer than it is broad. The cell containing the seed is near the base of the fruit (Fig. 3) leaving only a short pedicle or being really sessile, as in the recent species with single-seeded drupes (Fig. 7). Each drupe contains a single seed; and although, as I have said, the whole structure is replaced by calcite, yet the details are so beautifully shown that the connection of the seed by an internal unilateral placenta adnate to the whole length of the cell is in many cases obvious (Fig. 6). The seed is ovoid and compressed (Figs. 5 and 6), and the cicatrix at its base, by which it was attached to the placenta, can be detected.

The comparison of the drawings of *Sussea conoidea*, Gaud., taken

from Gaudichaud's Voyage sur la Bonite, plate 24, given on Plate IX. Figs. 7–11, with the figures of the fossil and the description I have given, must place it beyond doubt that this is a true *Pandaneous* fruit. I propose to designate the genus by the name of *Kaidacarpum*, Kaida being the Malabar name which Rheedee employed in his Hortus Malabaricus, from which book the younger Linnæus chiefly obtained the materials for his genus, although he adopted the later name, *Pandanus*, from Rumphius.

Besides the species which I have described, I have seen another in the Woodwardian Museum, Cambridge, from the Potton Sands, which, from its imperfect condition, it would have been impossible to have made anything of, but there is sufficient to establish that it belongs to this genus, and is a distinct species.

SYNOPSIS OF THE BRITISH PANDANEÆ.

GEN. I.—*Kaidacarpum*, gen. nov. Fruit composed of pyramidal rhomboidal single-seeded drupes, sessile, or sub-sessile on a thickened spadix.

Sp. 1. *K. ooliticum*, sp. nov. From the Great Oolite at Kingsthorpe. Plate IX. Figs. 1–6.

Sp. 2. *K. Bucklandi*, Carr. *Strobilites Bucklandi*, Lindl. and Hutt. Fossil Flora, Plate 129. From the Upper Greensand, Wiltshire.

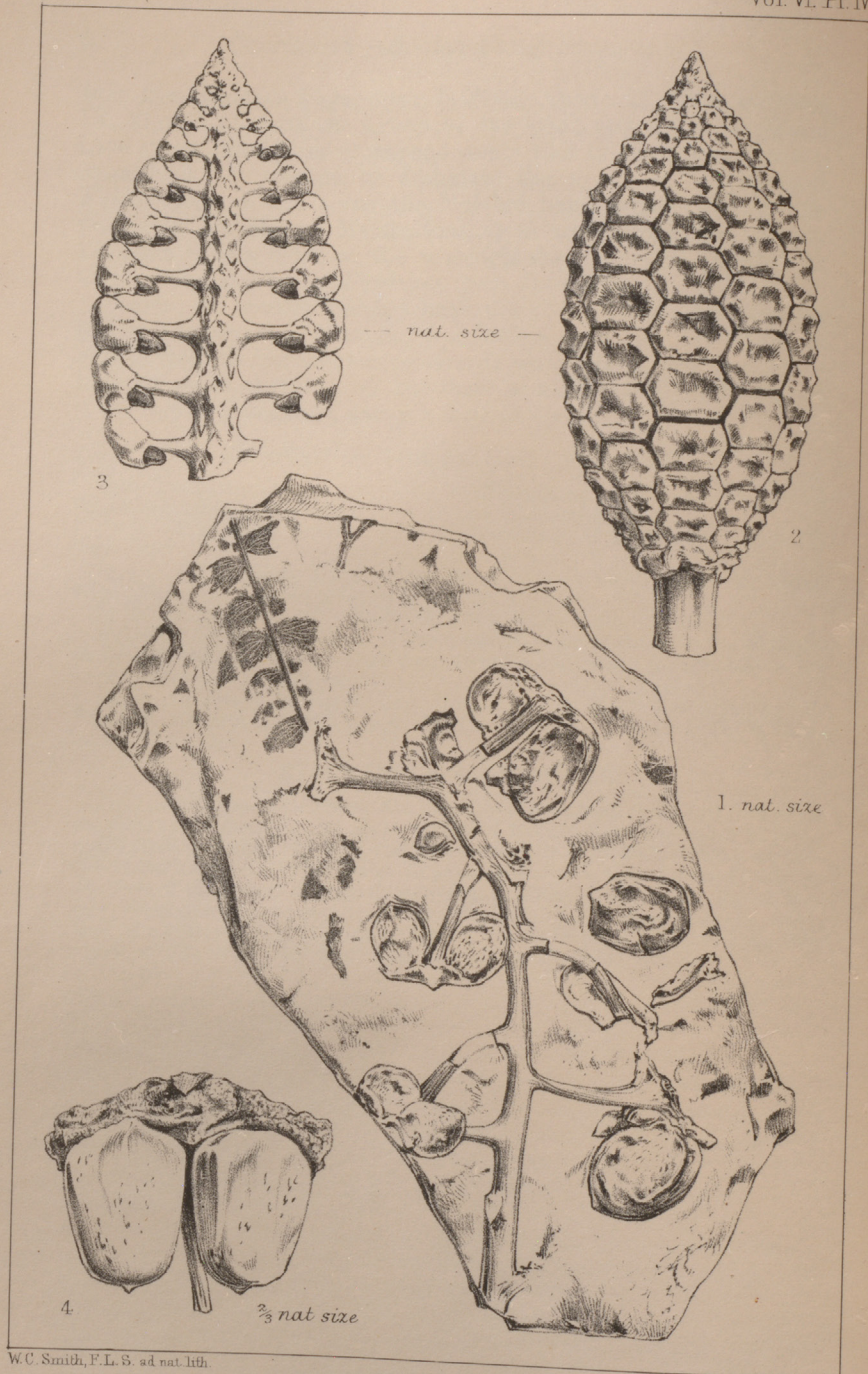
Sp. 3. *K. minus*, sp. nov. From the Potton Sands, Cambridgeshire.

GEN. II. *Podocarya*, Buckl. Fruit composed of an indefinite number of single-seeded cells united into one large compact spheroidal head, and attached to the spadix by long fibrous pedicles.

Sp. 1. *Podocarya Bucklandi*, Ung., Gen. et Species Plant. Fossilium, p. 327. Buckland, Geology and Mineralogy, Pl. 63. From the Inferior Oolite of Charmouth, Dorsetshire.

EXPLANATION OF PLATE IX.

Fig. 1. *Kaidacarpum ooliticum*. Nat. size, showing the bases of the cells from which the seeds have fallen out. The upper portions of the drupes are seen imbedded in the rock around the fruit.—Fig. 2. A portion from the side of the fruit, showing the relation of the seeds to the drupe.—Fig. 3. Ideal section of a drupe and seed.—Fig. 4. The form of the apex of a single drupe.—Fig. 5. Front view of seed.—Fig. 6. Side view, showing where the placenta touched the seed. Fig. 7. *Sussea conoidea*, Gaud. Half of a fruit.—Fig. 8. Longitudinal section of a single drupe.—Fig. 9. Transverse section of ditto.—Fig. 10. Seed, front view.—Fig. 11. Ditto, side view.



W.C. Smith, F.L.S. ad nat. lith.

W West imp.

1. *Beania gracilis*, Carr. Oolitic Shales of Yorkshire.
 2. 3. *Zamia muricata*, Willd. 4. *Macrozamia spiralis*, Miq.

ON *BEANIA*, A NEW GENUS OF CYCADEAN FRUIT, FROM
THE YORKSHIRE OOLITES.

By WM. CARRUTHERS, F.L.S., F.G.S., of the British Museum.

(PLATE IV.)

THE remarkable organs which are frequently associated with the *Zamia gigas* of Lindley and Hutton, and which have always been considered as in some way connected with the fructification of that plant, are the only fossils that can be referred to Cycadean fruits that have been hitherto observed in the Yorkshire Oolites, in which the remains of Cycadean leaves are so abundant. These organs have been made the subject of an elaborate memoir by Professor Williamson, presented to the Linnean Society some months since, and which it is to be hoped will soon appear in the Transactions of that Society. He has brought together so many observations, made during a life-acquaintance with these beds, that he has been able to re-construct, with every appearance of truth on his side, a singular genus, containing two well-marked species, and forming a new tribe of *Cycadeæ* very different from any living form.

Fruits closely related to those of the recent *Cycadeæ* have been found in Oolitic strata. Lindley and Hutton described, as a *Pinus*, a cone from the Inferior Oolite, which in a former communication to this Magazine (Vol IV. p. 101), I showed to be Cycadean, and named *Cycadeostrobus primævus*; and in the same paper I described a second species from the Oxford clay of Wiltshire, (*C. sphaericus*). I now add a third from Phillips's "Upper Shale" at Scarborough, which though agreeing in all essential points with the two species named, and with the living forms to which they are related, yet differs sufficiently to demand its being placed in a distinct genus. My colleague, Mr. Woodward, drew my attention to this interesting fruit, in that part of the Bean collection acquired some years since by the British Museum. It is not associated with any Cycadean remains on the small slab on which it occurs, so that there is no indication to which of the several leaf-species it belongs. I hope the publication of this notice, accompanied with Mr. Smith's admirable illustration, may bring to light other specimens that will supply this desirable information. A small fragment of *Acrostichites Williamsonis*, Brongn., occurs on the slab.

The diagnosis of the genus and species is as follows:—

Beania, gen. nov. Female fruit composed of scales arranged in loose spikes; scales stalked and peltate, supporting two ovoid sessile seeds, one on each side of the pedicel.

Beania gracilis, sp. nov. Axis of the female inflorescence slender; scales on slender stalks placed at right angles to the axis, peltate, apex of the scale small, scarcely covering the ripe seeds; seeds sessile, ovoid, slightly acuminate at the apex, symmetrically arranged on the two sides of the pedicel, reflexed.

Locality.—From the Oolitic Shale of Gristhorpe, near Scarborough, Yorkshire.

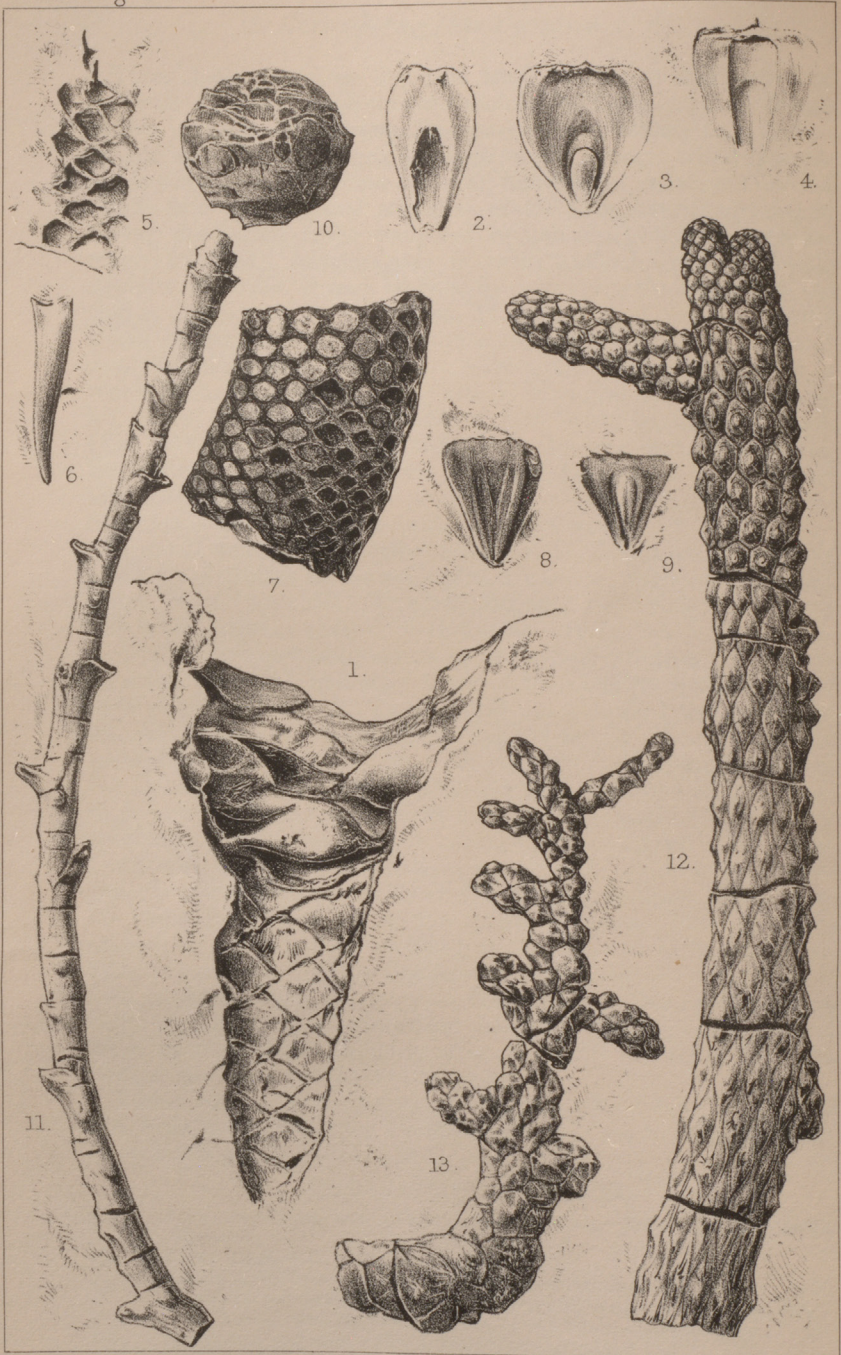
These characters show that this fossil belongs to that section of the order *Cycadeæ*, which was included in the Linnean genus *Zamia*. In the progress of discovery, this genus has gradually been broken up into nine distinct genera, arranged in two or more tribes (according to the views of different authors) based upon characters derived chiefly from the internal structure of the stem, but all agreeing in having the female fruits composed of two-seeded peltate scales arranged in cones. *Beania* agrees in every particular with the female strobilus of *Zamia*, as may be seen by comparing the fossil with the section of the cone of *Z. muricata*, Pl. IV., Fig. 3, except that the apices of the scales are not adpressed, but the scales are scattered over the axis so as to form a very loose spike. There is, however, a recent form, (*Microcycas*, D.C.), which, according to De Candolle, in his lately published monograph of this Order in the *Prodromus* (Vol. xvi., sect. 2, p. 538), differs from the other genera in having the scales of the female cone "loosely juxtaposed." In *Beania* this character is still more pronounced, so as to produce an inflorescence, which cannot be called a strobilus.

A small and very imperfect fragment of *Beania* was figured by Lindley and Hutton on the same plate with their *Sphæreda paradoxa*, Fossil Flora, Plate 159. This fragment is of itself sufficient to show that it had nothing to do with *Sphæreda*, but it is obviously too imperfect to give any information as to its true affinities. There are no seeds preserved, and only three of the pedicels retain traces of their peltate apices. Dr. Lindley had not examined the specimens. He only prints the descriptions supplied by Dr. Murray and Mr. (now Prof.) Williamson, jun. Dr. Murray's description refers to the *Sphæreda*; and Prof. Williamson thus describes the specimen of *Beania* which was confounded with it—"The stems of the smaller specimens are striated, and the lateral branches appear to have been terminated by a kind of round or oval leaf, which is one homogeneous mass of carbon, without the least appearances of any regular veins or striæ either in the stems or leaves. The carbon is excessively thick, instead of being in thin laminae as in most vegetable impressions." This description exactly agrees with what is seen in the specimen I have just described, and the explanation of those appearances, so anomalous to Prof. Williamson, is evident when the structure is properly understood, by the aid of the more perfect specimen now figured herewith.

I have sought to commemorate the successful labours of the late Mr. Bean in exploring the fossiliferous beds of the Yorkshire Oolites, by dedicating this genus to him.

EXPLANATION OF PLATE IV.

- Fig. 1. *Beania gracilis*, sp. nov. From a specimen in the Bean Collection, British Museum.
 Fig. 2. Young female cone of *Zamia muricata*, Willd.
 Fig. 3. Section of the same, showing the young seeds attached to the scales. Being a longitudinal section only a single seed is seen connected with each scale.
 Fig. 4. A single scale, with its two ripe seeds, of *Macrozamia spiralis*, Miq.
 Figs. 1, 2, and 3 natural size. Fig. 4, two-thirds the natural size.



W.G. Smith F.L.S. ad nat. lith.

W. West imp.

Comiferous Fruits, etc. from Secondary Rocks.



W.G. Smith F.L.S. ad nat. lith.

W. West imp.

Coniferous Fruits from Secondary Rocks.

ON SOME UNDESCRIBED CONIFEROUS FRUITS FROM
THE SECONDARY ROCKS OF BRITAIN.¹

By WM. CARRUTHERS, F.L.S., F.G.S., Botanical Department, British Museum.

(PLATES I. AND II.)

I. PINITES, *Witham*.

IN the paper on Coniferous Fruits I described in detail the structure of three cones which had originally been described as, and all along believed to be, Cycadean. These cones were *Zamiostrobus macrocephalus*, Endl.; *Z. ovatus*, Göpp; and *Z. Sussexiensis*, Göpp. In making, in June last, a careful comparison between the version of M. Brongniart's important essay, "Exposition Chronologique des Périodes de Végétation et des Flores diverses qui se sont succédé à la surface de la Terre," published in the *Dict. univ. d'Hist. Nat.* 1849, and the version in the *Ann. des Sc. Nat.*, Ser. III., Vol. xi., p. 285, bearing the same date, but which evidently, from the occasional emendations, had had a careful and later revision by its learned author than the copy with which I had heretofore been working, I found that M. Brongniart had already referred two of the species to the genus *Pinites*. On a foot-note on pp. 317, 318 of the volume quoted he gives the following reason for this change: "Un échantillon de ce fruit (*Zamiostrobus macrocephalus*) qui vient de m'être communiqué par M. Wetherell, établit d'une manière bien positive que ce n'est pas un fruit de *Zamia*, mais un cône de *Pinus* ayant tous les caractères de ce genre, relativement à la forme et à la direction des écailles, et à la position des graines géminés à leur base. Quant au *Z. Sussexiensis*, son analogie avec le précédent me paraît évidente." To M. Brongniart then belongs the credit of having first correctly determined the affinities of these two cones, and they must be quoted as *Pinites macrocephalus*, Brongn., and *P. Sussexiensis*, Brongn.

To the species already recorded of this genus, I have to add two new and striking species from Cretaceous Rocks, and a third from the Upper Oolites.

¹ This paper is supplementary to two papers published in Vol. III. of the *Geol. Mag.*; the one "On Araucarian Cones from the Secondary Rocks of Britain," at page 249; and the other "On some Fossil Coniferous Fruits," at page 534.

1. PINITES LECKENBYI, *sp. nov.* Plate I. Figs. 1-5.

Cone oblong-ovoid, with an obtuse or subtruncate apex; scales very broad, not thickened at the apex; seeds small ovoid.

Locality.—Lower Greensand of Shanklin, Isle of Wight.

This beautiful cone forms part of the collection of John Leckenby, Esq., F.G.S., Scarborough. It is preserved in its original form, and so perfectly fossilised, that the various details of its structure can be determined as satisfactorily as in a recent cone. It is 4 inches long, and 2 inches broad. There is still attached to it a portion of the branch which supported it, represented on Fig. 4. The structure of the interior, as disclosed in the longitudinal section (Fig. 2) agrees in every character of importance with that of the cone of *Pinus Cedrus*, Linn. The scales are marked with parallel striæ, curving upwards and outwards from the base (Fig. 3). Several of the seeds exhibit the embryo in the centre of the albumen, and in one the section is so made as to show the divisions of the Cotyledons (Fig. 5). That this structure may be the better understood, I have placed beside it on the Plate a copy (Fig. 6), from Richard's *Memoire sur les Conifères*, (pl. 14, fig. H,) of a section of the seed of *Pinus Cedrus*, Linn.

The affinity between this cone and the recent cedars is so obvious, that it would be wasting words to dwell upon it; but it may be interesting to remark that this group of pines, which is confined, according to Parlatore in his recent Monograph of the Coniferæ,¹ to two species, the cedar of Lebanon and the Deodar, formed a striking characteristic of the Cretaceous flora. Besides the species just described, two others have been found in our British rocks, *P. Benstedii*, Endl., and *P. oblongus*, Endl.,² both from the Lower Greensand. Another species, *P. Corneti*, Coem., forms part of that remarkable local flora of Cycads and Conifers of Cretaceous age, described by M. Coemans, from La Louvière.

2. PINITES GRACILIS, *sp. nov.* Plate I. Fig. 9.

Cone elongated, cylindrical, tapering at the extremities into somewhat acute ends; apex of the scale rhomboidal, somewhat thickened.

Locality.—The Gault of Eastware Bay, near Folkestone.

I am indebted to J. S. Gardner, Esq., F.G.S., for my acquaintance with this cone. He has two specimens in his collection. They are $3\frac{1}{2}$ inches long, and $\frac{3}{4}$ of an inch broad. The cone is singularly different from any species, recent or fossil, with which I am acquainted.

PINITES DEPRESSUS, *sp. nov.* Plate II., Fig. 10.

Cone small, cylindrical, depressed at the apex; scales short, very broad, thin at the apex.

Locality.—Kimmeridge Clay of Weymouth.

¹ De Candolle's Prodrômus. Vol. xvi., Sec. 2, p. 407. Paris, 1868.

² The original and as yet only known specimen of this species is in the Museum at Oxford.

The materials for establishing and describing this species are somewhat imperfect; but as this is the only coniferous fruit yet recorded from the Kimmeridge clay, and as it is a well marked, though probably a young cone, it seemed to be desirable to figure it. It is 10 lines long, and 11 lines broad. It is in the collection of the British Museum.

II. ARAUCARITES, Unger.

Since the publication of my paper on Fossil Araucarian Cones (GEOL. MAG., Vol. iii. p. 249), I have had the opportunity of examining the as yet unique specimen of *Araucarites Pippingfordensis*, Carr., with which I was then acquainted only from Fitton's accurate figure. This examination has confirmed the opinion I then formed that this fossil was nearly allied to *A. sphærocarpus*, Carr., and that they both belonged to the section represented by the Australian species, which, from their peculiarities, have been separated from the American species by some authors as a distinct genus with the name *Eutacta*. I may also mention here that unwittingly I introduced an *i* into the specific name, which should not be there, following the erroneous spelling of Unger's *Synopsis*.

I have now to add two additional species belonging to this genus, both from Oolitic rocks; founded principally on the detached scales which occur, the one in great abundance at Stonesfield, and the other somewhat more rarely in Yorkshire.

1. ARAUCARITES BRODIEI, *sp. nov.* Plate II. Figs. 1-6.

Scales from the centre of the cone cuneate, gradually tapering towards the narrow base of attachment to the axis, composed of two portions, each terminating at its free apex in a short spinous process, the lower and larger portion very broad and membranous, the upper portion narrower and somewhat parallel-sided, supporting between them a single ovoid seed.

Locality.—From the Stonesfield Slate of Stonesfield.

I first noticed this species when examining the large collection of Stonesfield slate fossils in the Oxford Museum, and part of my illustrations are from a specimen which Professor Phillips permitted me to have the loan of from his private collection. The scales are scattered over the surface of the slate, exhibiting, as is the case with the fossils of this bed, only casts of the organism slightly coloured with the remains of the mineral carbon into which they were converted. In some specimens the cast of the three parts of the scale are clearly seen, viz., the upper and under scales and the seed. The scales are from eight to eleven lines long, and from six to twelve lines broad at the widest parts. They present the double apex characteristic of the section *Eutacta*. In the collection of the Rev. P. B. Brodie I have found the cast of the lower portion of a cone, with an inch and a half of the supporting branch, marked by the scars of the leaves. This fragment exhibits the attachment of eight scales, and clearly establishes the true nature of the detached specimens. This is the more important, as the scales have been described as

complete organisms by M. Pomel,¹ who has detected them in the Jurassic rocks of St. Mihiel and De Seyssel in France. He thus describes the specimens and interprets their meaning:—"The most remarkable of these organs are the ovate-lanceolate scales, which thin towards their apex, and have an oblong cavity hollowed out of their upper portion for the reception of an oblong somewhat compressed seed. The similarity in the form of their impressions show that they were really more or less foliaceous scales. If the apex is mistaken for the base they might be taken for the detached scales of an *Araucaria*. But in examining a number of these scales it becomes evident that the enlarged end is the base, because of its concavity, 'et en outre elle est toujours accompagnée d' une autre empreinte en portions de cercle, large mais courte et se terminant évidemment par un court ongle.' The thickness of this impression indicates that the fossil was a strong scale on a large spathulate leaf, upon which was inserted the carpillary scale,—the whole being certainly borne at the termination of a branch. This forms the whole female organ, and exhibits a great analogy to the fruit of *Taxineæ*,—to that of *Dacrydium* for example, which is in the same way borne on a terminal thickened and dilated leaf. The discovery of a fragment of a branch terminating in one of these carpillary scales dispels all doubt as to this interpretation of their structure. They were then *Taxineæ*, but without drupaceous fruits, the ovule being enclosed in a true and not fleshy scale. They form a small extinct family near *Taxineæ*, which may be called *Lepidocarpeæ*. The male buds are ovoid, or cylindrical-oblong, and are composed of scales more or less broad at the base, recurved at the apex, and loosely or compactly imbricated. Traces of stamens can be detected on the scales, probably coriaceous and thick, but their characteristics cannot be clearly determined."

After examining the various species of Conifers of Oolitic age, based as they are chiefly upon the foliage, he concludes that there is no reason for placing them in separate genera, and he consequently establishes a new genus *Moreauia*, rejecting all the names hitherto employed, because, with a single exception, they suggest false analogies, and that excepted name (*Brachyphyllum*) is applicable only to a section of the whole. He describes eight new species from the French Oolites, and places 25 other species in his genus, most of which have been long known under the names *Brachyphyllum*, *Thuites*, *Cupressites*, *Araucarites*, *Lycopodites*, *Cunninghamites*, *Taxodites*, and *Taxites*. M. Pomel promises a more complete justification of his views in a monograph of the genus shortly to be published, but which, as far as I have been able to ascertain, has not yet made its appearance.

I have quoted M. Pomel's observations at length, as they are, if they can be established, most important, inasmuch as they introduce to science a new and singular tribe of extinct *Taxineous Coniferae*.

¹ Amtlicher Bericht über du xxv. Versammlung der Gesellschaft Deutscher Naturforscher und Aerzte in Aachen, Sept., 1847, pp. 347-352.

Genera established upon foliage are at the best unstable, and affinities determined only on such materials are nearly always unsatisfactory. There need, then, be no insuperable barrier to the union of all these various forms in a single genus, if the organs of reproduction were found to be similar. That genus would indeed be very variable in its foliage if it included such forms as *Brachyphyllum* and *Cunninghamites*, but a wider variation is known in the very natural genus *Podocarpus* among living *Coniferæ*. M. Pomel maintains that the organs of reproduction are the same; but that opinion rests only on the observation, as he believes, of a single specimen of the connection of foliage and fruit, in one of his 33 species; and in maintaining this position he is obliged to set aside the observation of M. Brongniart in regard to the fruit of *Taxites podocarpoides*, Brongn. In the numerous examples from the Stonesfield slate which have passed under my observation I have not met with a single specimen which would support M. Pomel's opinion. If the conditions of the St. Mihiel rocks are similar to what exists at Stonesfield, as appears from M. Pomel's descriptions, every one acquainted with our English rock must know how easy it is to be deceived in attempting to unite fragmentary fossils from mere juxtaposition of impressions which does not in the least testify to former organic connection.

The structure of the scales as exhibited in the better preserved specimens, places it beyond doubt that M. Pomel has mistaken the apex for the base of the organism. The apex of the scale is double, each portion representing one of the two structures of which the Araucarian scale is composed, and which can be easily distinguished in numbers of the specimens. Each of these portions terminates in a short free spinous process. It would be quite anomalous to have such a double attachment for a single fruit. Taking, however, the interpretation I propose, everything is intelligible,—the form of the scale, the position of the seed, the broad membranous wings to the scale, and the double apex, all agree with what occurs in the Australian species of *Araucaria*, and with what I have shown to be the structure of *Araucarites sphaerocarpus* (GEOL. MAG., Vol. III., p. 252). And that this is the true interpretation of the scales is established by the cast of a fragment of a cone from the Rev. P. B. Brodie's collection figured on Plate II., Fig. 1.

There is a considerable variety in the size and form of the scales scattered over the surface of the slate, but they all agree in bearing a single seed, and in having a more or less extended membranous margin to the scale. The difference in form may indicate the existence of more than one species, but I am rather inclined, from the materials I have examined, to consider it due to the position on the cone which the different scales occupied. Figures 3 and 4 represent the most abundant found; specimens occur considerably larger than those figured; Figure 2 is a form of which I have several examples. Except that the scales of *Araucaria excelsa*, the species found on Norfolk Island, are considerably larger than those of the fossil, they agree remarkably in every other respect with them.

In explanation of the occurrence of so many separate scales, and the rarity of cones, it deserves to be remarked that, unlike the cones of our northern *Abietinæ*, the scales very readily separate from the axis in *Araucaria*, so that it is difficult to preserve them whole in collections.

Impressions of two fragments of branches have been seen by me in the Stonesfield slate, which most probably belonged to this species (both in the collection of the British Museum), of one of which a portion is figured on Plate II., Fig. 5.

I have also observed a leaf agreeing in the size of its base with the scars on the branches, and in form with the leaves of some living species of *Araucaria*. It is represented at Figure 6 of the same Plate.

2. *ARAUCARITES PHILLIPSII*, *sp. nov.* Plate II. Figs. 7-9.

Scales from the centre of the cone cuneate, nearly as broad as long, lower scale thickish throughout, without membranous wings.

"Winged seed," Phillips' Geology of Yorkshire, ed. I. (1829), p. 190, plate x, fig. 5.

Locality.—Inferior Oolite or Lower Calcareous Sandstone shales (Phillips) of Yorkshire.

Professor Phillips observed these scales in the beds at Haiburn Wyke. He was evidently unable to determine to his own satisfaction what they were, and so modified his first suggestion that they were probably the seeds of *Cycadites*, at page 150, to the more general designation, "Winged seed," at page 190.

When I detected the species just described in the Oxford Museum, Prof. Phillips drew my attention to the similar organisms from Yorkshire. They are smaller in size than the species just described, being from six to eight lines long by about six lines broad. The structure of the scale, with its single median seed, although not so clearly exhibited as in the casts of specimens in the Stonesfield slate, is sufficient to show, without any doubt, that it is an *Araucarian* scale. Additional evidence confirming this opinion is obtained from a fragment of a cone in the collection of Prof. Williamson, of Manchester, and which he has been good enough to let me have for the purpose of figuring it. This specimen (Fig. 7) is a portion of a rubbed cone, imperfect at both extremities, with the scales abraded to near the axis, showing the cavities which held the seeds, and these are filled on one side of the cone with carbonate of lime, which takes the form of the seed it has replaced. Each scale bears a single seed, as in *Araucaria*, and the size of the scale and the seed corresponds with that seen in the detached scales. As this fragment is from the same deposit as the scales, it may fairly be concluded that it is the cone of *Araucarites Phillipsii*. It shows it to have been smaller, more cylindrical, and to have been composed of smaller, shorter, and more broadly cuneate scales than *A. sphaerocarpus*, Carr., found in beds of the same age at Bruton, Somersetshire.

Professor Phillips figures the apex of the scale terminating in a single short apiculus. I have not been able to detect this, but the

mineral condition of the specimens, and the shale in which they are preserved, make it difficult to determine clearly minute points in their structure. It is probable from the apparent absence of the double apiculus to the scales, and the want of the membranous wings, that this species may belong to the section of the genus named *Colymbeia* by Salisbury, and confined among living plants to the species inhabiting South America.

Setting aside the unsatisfactory evidence of foliage and wood, we know, from the remains of fruits of the existence of five species of *Araucaria* in the Secondary rocks of Britain. One Cretaceous *Araucarites Pippingfordensis*, Carr., from the Wealden, and the others Oolitic, one undescribed and apparently lost, but determined by Robert Brown, from the Purbeck, one *A. Brodiei*, Carr., from the Stonesfield slate; and two *A. sphærocarpus*, Carr., and *A. Phillipsii*, Carr., from the Inferior Oolite.

SEQUIOITES GARDNERI, *sp. nov.*, Plate I, Figs. 7, 8.

Cone oval, scales peltate, the rhomboidal apex, smooth, depressed in the centre, broader than deep; leaves falcate, incurved, subquadrangular in section, arranged spirally on the branch.

Locality.—The Gault of Eastware Bay, near Folkestone.

For this second British Cretaceous species of *Sequoiites* I am indebted to J. S. Gardner, Esq., whose researches in the Gault of Folkestone I desire to acknowledge by associating his name with the species.

APPENDIX.—The remarkable branches from the Oxford Clay which are represented by Figures 11–13 of Plate II. are placed there with the view of eliciting information regarding them, rather than for the purpose of adding names and descriptions, which mean nothing, to the already long list of uncertain objects that occur in every enumeration of fossil plants. Both forms—that of Figure 11, but especially that represented by Figures 12 and 13—are very remarkable, and easily recognisable. It would specially help to a satisfactory determination of the true nature if either foliage or fruit could be found associated with them.

EXPLANATION OF PLATES I. AND II.

PLATE I.

FIG. 1. *Pinites Leckenbyi*, Carr.

2. Section of the same through the axis; the scales and the seeds. The section is not continued to the base of the cone, the lower and lighter coloured portion being fractured.

3. A scale with two seeds at the base.

4. A portion of the base of the cone seen from below, and exhibiting the remains of the supporting branch.

5. Section of one of the seeds considerably magnified, showing the embryo, in the middle of the albumen, with the division of the Cotyledons.

6. Section of a seed of *Pinus Cedrus*, Linn., for comparison with Fig. 5. From Richard.

7. Cone of *Sequoiites Gardneri*, Carr.

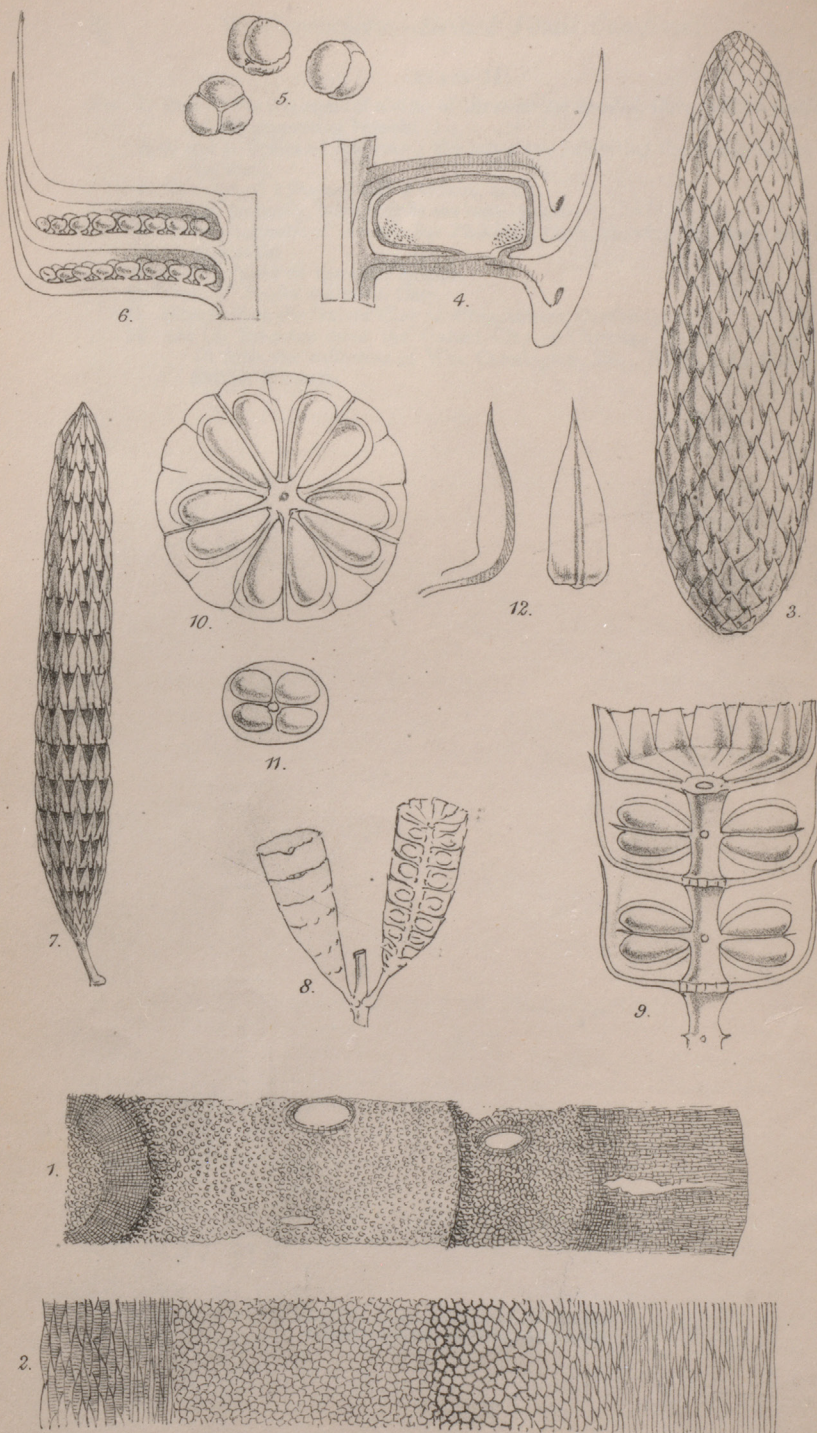
8. Fragment of a branch of the same.

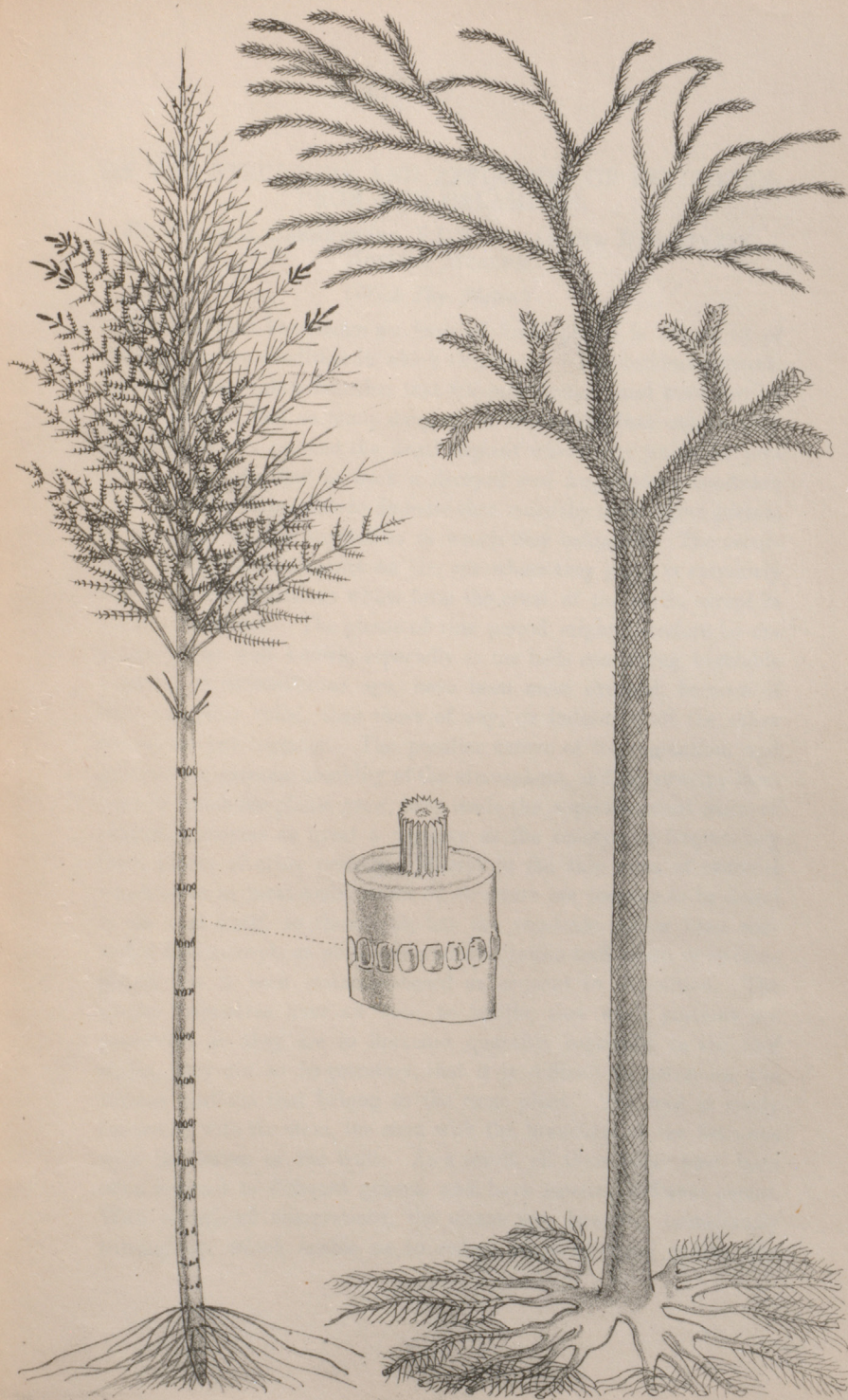
9. Cone of *Pinites gracilis*, Carr.

PLATE II.

- FIG. 1. Cast of the fragment of a cone of *Araucarites Brodiei*, Carr., with a portion of the supporting branch.
 2, 3, and 4. Scales of the same; the latter two exhibiting the double nature of the apex.
 5. The cast of a fragment of a branch, and
 6. A leaf, probably, belonging to the same species.
 7. Rolled fragment of *Araucarites Phillipsii*, Carr., showing the single seed in each scale.
 8 and 9. Scales of the same species.
 10. Cone of *Pinites depressus*, Carr.
 11. Branch from the Oxford Clay of Chippenham, Cambridgeshire.
 12 and 13. Branches from the Oxford Clay of Christian Malford, Wiltshire.
 12 from the collection of Wm. Cunnington, Esq., F.G.S.; 13 from the British Museum.

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ON THE STRUCTURE AND AFFINITIES OF LEPIDODENDRON AND CALAMITES.

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(*With Two Plates.*)

The imperfect knowledge we have of fossil plants is the result of the fragmentary condition in which they occur. The deciduous leaves, ripe fruits, or broken branches that fell into streams, and were carried to sea or lake, had so many dangers to encounter, that only a very few of them ever reached the usual deposit where they would be preserved, and these few in such a decayed and fragmentary condition that it is often impossible to do more than make the most vague guesses at the nature of the vegetation to which they belonged. The occurrence of vegetable remains on the site where they grew, is extremely rare in all the formations which form the crust of the earth, except in the coal-measures. The plants of this period might therefore be expected to be well known, especially as the beds containing vegetable remains, of carboniferous age, have been more exposed, because of their economic value, than those of any, or indeed of all the other formations put together. The peculiar nature of the vegetation, and perhaps the extreme humidity of the atmosphere, and the swampy localities in which the plants grew, have made the superabundant mass of vegetable remains as great a mystery as the scanty and fragmentary fossil plants of other periods. Except in the thin films of charcoal which occur in most coals, traces of structure are scarcely to be found in the coal itself, so thoroughly has the vegetable matter been converted into amorphous pulp before mineralization took place, or so completely has it been metamorphosed subsequent to deposition. The plants themselves have all been so brittle, that when portions are preserved, as they are in immense quantity, especially in the roof shales, they are so fragmentary, that it is difficult to determine the various portions that belong to the same plant. The root is rarely connected with the stem, the stem with the branches, or the branches with the leaves or the fruit. As a result, all these parts have been often referred to different genera, and have received different names. With additional observations, the means are, however, occasionally turning up, which enable us to reduce some of these genera, the

establishment of which was absolutely necessary in the earlier days of palæontological botany. Thus, to give an example:—the trees belonging to the same set as those which were found imbedded in the sandstones at Craigleith quarries have been constituted into the genus *Dadoxylon*; the pith forms the genus *Sternbergia*, and some fluted and constricted specimens have been referred to *Calamites*. The leaves were considered to be ferns, and named *Cyclopteris*; and the fruit was thought to belong to a Palm, and received the name of *Trigonocarpon*. We have not seen evidence sufficient to convince us that all these are correctly referred to the same plant; but this is the opinion of some distinguished palæontologists, and it serves as a good illustration of the present satisfactory tendency of palæontological botany.

A similar multiplication of generic names encumbers the synonymy of the two genera *Lepidodendron* and *Calamites*.

Lepidodendron was a branching tree of considerable size. It is separated from the other genera of coal plants by the form and arrangement of the leaf-scars upon its stem. More than forty species have been recorded; but as the scars present different appearances on different portions of the same plant, no doubt more species have been established than the materials fairly warrant. But that they were numerous in species, and very numerous in individuals, any one who has even cursorily examined a coal-pit, or the fossils in any public museum, must be convinced. They certainly contributed largely to the formation of coal.

The researches of Witham,* Lindley and Hutton,† Brongniart‡ and Binney,§ have made us acquainted with the stem. These published

* 'The Internal Structure of Fossil Vegetables,' 1833.

† 'The Fossil Flora of Great Britain,' 1831–1837.

‡ 'Observations sur la Structure intérieure du *Sigillaria elegans*, etc.'—*Archives du Muséum*, 1839.

§ 'Geological Society's Journal,' 1862, and 'Philosophical Transactions,' 1865. Mr. Binney, in these papers, gives most careful and elaborate drawings and descriptions of some fossils in his extensive collection. He refers them to the genus *Sigillaria*, because of their agreement in internal structure with Brongniart's *S. elegans*; but he cannot separate them by their external markings from *Lepidodendron selaginoides*, Lindl. and Hutt.; and as the only characters by which the two genera are distinguished are derived from the markings on the stem, we must consider *Sigillaria vascularis* as a true *Lepidodendron*. I am the more satisfied as to this, because I believe no essential difference exists, as has been hitherto maintained, between the stems of *Sigillaria* and *Lepidodendron*, or any of the other lepidodendroid plants of the coal period. I cannot enter into this question here, but I shall take an early opportunity of publishing my views, and the reasons for maintaining them.

observations, together with the examination of some beautiful specimens in the collections of Robert Brown, now in the botanical department of the British Museum, and of Mr. Alexander Bryson, enable me to give a somewhat complete description of its singular structure.

The axis of the stem cannot be considered as a true medulla or pith, inasmuch as it is composed not of simple cells, but of elongated utricles of various sizes, irregularly arranged, and having thin walls marked with scalariform bars (t. 56, f. 2). These utricles, indeed, differ from the vascular tissue of the woody cylinder which surrounds them only in their length. The tissue of the woody cylinder consists of long scalariform vessels, which increase in size from the inner margin to the outer, this increase being sufficient to meet the requirements of the enlarged circumference, with the help of only a few additional series of vessels. As there is no true medullary cellular tissue in the axis, so there are no medullary rays passing through this cylinder. In radial sections an appearance is seen singularly resembling, to the naked eye, the "silver grain" produced in dicotyledonous woods by the medullary rays; but this arises from a very different cause. The diameter of the vessels is so great, that on a polished surface only the scalariform wall of the vessel, that lies on or near the surface, is exhibited; and when the upper wall of a vessel is cut away, the lower wall is often so deeply buried in the opaque substance, that the peculiar structure is obscured. In the case of sections prepared for microscopic examination, both surfaces of some vessels are often removed, and the scalariform markings on the lateral walls, or on any horizontal walls which by chance occupy a medial position between the polished surfaces, only are seen. This absence of the scalariform bars gives at first sight the appearance produced by medullary rays.

The continuous cylinder of scalariform vascular tissue appears to be penetrated by the vascular bundles which ultimately supply the leaves. These bundles apparently originate either in the scalariform tissue of the axis, or on the inner surface of the woody cylinder. They have been mistaken for, or misnamed, medullary rays.

The woody cylinder is surrounded by a great thickness of cellular tissue, which extends to the exterior of the stem, and is composed of three distinct and separable zones. The inner zone has never, as far as I know, been perfectly preserved in any specimen, yet traces of it sometimes may be seen; and it is rightly restored in Brongniart's

drawing of *Lepidodendron Harcourtii*, in the 'Archives du Muséum,' vol. i. plate 31. Its absence in fossils is owing to its extremely delicate structure. The cells of the middle zone have thicker walls, and they have consequently frequently resisted decomposition before fossilization made them permanent. In the outer zones the cells are very much lengthened, and have a smaller diameter.* They nearly resemble true vascular tissue; but the progress of lengthening may easily be traced from the interior outwards, and no distinction can be drawn between the true cells, and the long and slender ones of the outer circumference. The cell-walls of all the three zones are without markings of any kind.

These three cellular zones are traversed by the vascular bundles which rise from the outside of the interior woody cylinder, if they do not actually pass through it, and pass to the leaves and branches. These bundles separate from the woody cylinder a long way below the point where they pass off into the leaf. At first their direction is almost parallel with the cylinder, slightly inclining outwards; they then incline more outwards, and as they approach the circumference of the stem, they resume their nearly ascending direction for some distance, until they finally pass out to the leaves which they support. Each bundle consists of scalariform vessels, very much finer than those of the woody cylinder, surrounded by elongated cells like those of the outer zone, and probably still further enclosed by a delicate parenchyma, which disappeared before it could be fossilized. The only evidence I have of the existence of this cellular tissue is, that the bundles never fill the cavities in the parenchyma of the stem through which they pass. The bundles terminate in the points seen on the areoles of the stem, which are the scars of the leaves.

The woody cylinder is of different thicknesses in different stems, and appears to have increased with the growth of the tree. There is, however, no indication of interruption in the growth or of seasonal layers. Yet it cannot be conceived that the whole vascular cylinder arose and was developed at the same time. It is very probable that the zone of slender, and consequently rarely preserved cellular tissue which surrounded the woody cylinder, was analogous in its functions to the cambium layer of phanerogamous stems, like the similar layers in recent *Lycopodiaceæ*, described by Spring in his 'Monographie de la Famille des Lycopodiacées' (page 294).

If we separate the different structures we have described in the axis into two series, the one series axial, and the other epidermal, we shall have the axis composed of scalariform utricles, the woody cylinder and the vascular bundles passing to the leaves belonging to the first series, and the two external zones of the vascular tissue to the second. The inner zone of cellular tissue, like the cambium layer, was most probably common to both series, the cells of the outer circumference being developed into the parenchyma of the epidermal series, while the vessels of the woody axis were produced from the cells of the inner series.

Stigmarioid roots have been determined to belong to *Lepidodendron* as well as to *Sigillaria*, and their whole structure supports this determination. I have satisfied myself that there is nothing that can be truly called a medullary ray in the woody cylinder of *Stigmaria*, but into the proof of this I will not now stay to enter. The base of the trunk was divided into a few principal roots, and these again divided dichotomously, but the ultimate divisions were never much attenuated. Throughout their whole course, and from every portion of their circumference, they gave off rootlets of considerable length, which, with the exception of a slender vascular bundle, were entirely composed of delicate hexagonal cells. They were articulated to flagon-shaped bodies sunk in cavities, arranged in a quincuncial manner over the stem. The internal structure of the *Stigmaria* root corresponds to that of the trunk of *Lepidodendron*. The axis was composed of fusiform barred cells, and this was surrounded by a woody cylinder, which was certainly penetrated by the vascular bundles that supported the rootlets. Beyond the woody cylinder came a great thickness of cellular tissue, almost always destroyed, but probably agreeing in its structure with the three zones of the stem.

In speculating upon the conditions under which the forests of *Lepidodendron* flourished, it is most important to observe whatever is peculiar in those organs by which the plants were connected with the physical conditions around them. Geologists have too much overlooked such considerations in their deductions as to the physical phenomena of a period from the plants and animals that then existed. They have often taken for granted that the known conditions of the living species of a genus are true also of the fossil members of the same genus. In the want of other evidence, such an assumption may be cautiously employed; but unless its true value be accurately estimated,

the greatest errors may arise, as they have in the past. For example, the systematic position of *Elephas primigenius* having been clearly established, the inference was thought legitimate that, as the modern representatives of the genus were confined to tropical or subtropical countries, the boreal regions must have enjoyed a similar climate when they were inhabited by these ancient elephants. It was, however, discovered that their skin was clothed with wool and long hair, and that, consequently, they were adapted to endure a cold climate. In plants, the structure of the fruit would in most cases teach nothing as to the temperature and humidity of the atmosphere in which, or the kind of soil upon which, the organism grew, though it would be of the first importance in determining systematic position. On the other hand, the root, the leaves, and the tissues of the plant, would be of only secondary importance in regard to systematic position, but of the highest value in determining physical condition. In regard to *Lepidodendron*, its singular roots would seem to imply that it derived a large amount of moisture through them from a moist soil, and so far differed from most living cryptogamia, which obtain it mostly from the atmosphere. The roots of this genus presented in their crowded and long rootlets an immense surface for the absorption of moisture; and in their great abundance of lax cellular tissue possessed the means of containing this moisture, and transmitting it to the foliage.

The leaves of *Lepidodendron* were simple, lanceolate, acute, and sessile. They had a single medial nerve. The younger branches were densely covered with leaves; and the scars left on the trunk after they perished, give the numerous beautiful markings by which the species have been distinguished. The leaves when found separated from the branches, are called *Lepidophylla*.

The fruit was a strobilus (t. 56, f. 3), formed from a shortened branch, the leaves of which are converted into scales, that support on their upper surface a single large sporangium (*Lepidostrobus*, t. 56, f. 4), or perhaps several small ones (*Flemingites*, t. 56, f. 6). There appear to be both macrospores (t. 56, f. 5) and microspores in the same sporangium. I have examined at length the structure and affinities of these fruits, in a paper published in the 'Geological Magazine,' vol. ii. p. 433, to which I must refer, without here dwelling further on the subject. *Flemingites*, although the sporangia are enormously abundant in some coals, have not yet been found connected with any

fossil; but specimens of *Lepidostrobus*, attached to branches of *Lepidodendron*, have been described by Dr. Paterson, Brongniart, and others; and I have noticed a fine specimen in the Museum of the Edinburgh Botanic Gardens, and others exist in the collections at the British Museum and elsewhere.

In tracing the affinities of *Lepidodendron*, we have the safest guide in the organs of fructification, and fortunately these have been satisfactorily determined. The sporiferous strobilus shows that it is a true cryptogam; and in general appearance and arrangement of parts, the strobilus can scarcely be distinguished from that of some living *Lycopodia*, except in the great difference of size; this affinity is strengthened by the character of the leaves, and the structure of the stem. But the possession of both kinds of spores in the same sporangium exhibits stronger affinity to *Rhizocarpeæ* than to *Lycopodiaceæ*.

The structure of the arboreal stem of *Lepidodendron* is much more complex than that of any known cryptogam. The central axis of irregularly-arranged vascular tissue in *Lycopodium* is suited to the low stature of the plants of that genus; but in the giant *Lepidodendron* there is a complexity, which approaches the structure of some dicotyledonous stems. The general arrangement of the tissues, resembling what exists in some *Cycadeæ* and *Cactaceæ*, has caused this fossil plant to be referred sometimes to the one, and sometimes to the other of these Orders; but the resemblance is only one of analogy, and not of affinity. The presence of scalariform tissue, of which the woody portion is entirely composed, and the absence of medullary rays, would, even if the fruit were unknown, be sufficient to establish the cryptogamic nature of the plant. A comparison with the Cycadean stem may help us, by the resemblances and differences which will appear, better to understand the stem of *Lepidodendron*. The Cycads have all a large medulla, composed of large-sized parenchyma; in some genera traversed by numerous vascular bundles, as in *Encephalartus*, and in others entirely cellular, as in *Cycas* and *Zamia*. This is surrounded by a single woody cylinder, or several, everywhere penetrated with medullary rays. Beyond this there is a considerable thickness of parenchyma, composed, in their inner portion, of cells whose length exceeds only slightly their breadth; these gradually lengthen, until they assume an appearance very like the external portion of *Lepidodendron*. This cortical parenchyma is traversed by the vascular

bundles which supply the leaves. The two stems are evidently built upon the same plan; and were we to substitute scalariform tissue for the gymnospermatous woody tissue, and scalariform utricles for true medullary parenchyma, and finally exclude the medullary rays, the description of the Cycadean stem would apply to that of *Lepidodendron*. And it deserves special notice, that the surface of the Cycadean trunk is composed of the bases of the old leaves, together with the scales which in some species are interspersed among them, or alternate with them. The leaves do not disarticulate at the circumference of the stem, but at some distance from it, leaving a small portion of the base persistent. The scars of the outer surface of the stem give a different impression from those presented when the persistent bases of the leaf-stalks are removed. Whoever is even a little familiar with coal fossils is aware that there are two sets of scars on the stems of *Lepidodendron*—one superficial, the other internal. The fossils that present the first set are generally said to be "corticated" stems, and those exhibiting the others "decorticated." The "bark" is generally converted into a compact structureless coal, the outer surface of which has the one set of scars, and the inner surface the other. I believe this coal is produced by the external of the two epidermal series, and that the outer scars were truly superficial, while the inner were produced by the vessels which passed to the bases of the leaves. The two sets of scars in Cycadean stems are analogous structures; but in *Lepidodendron*, the layer which bears the scars on its two surfaces is a compact cylinder; while in the *Cycadeæ* there is no connecting tissue uniting the bases of the leaves; they are closely packed together, but quite free from each other. It is evident that in many respects the fossil stem had a striking analogy in the arrangement of its parts to that of the recent Cycads, while it was, however, a true Cryptogam; and if we now examine the slender stem of *Lycopodium* we shall find, I believe, that *Lepidodendron*, though more highly developed, does not differ essentially from it.

Spring, in his 'Monographie des Lycopodiacees' (p. 293), describes the stem of this Order as composed of five parts:—1st. The woody axis; 2nd. A layer of delicate cells; 3rd. The liber; 4th. The herbaceous envelope; and, 5th. The epidermis.

The axis is composed of bundles of scalariform vessels, scattered through a very delicate cellular tissue, in a regular figure, which varies

in the different species. This axis is surrounded by a layer of lax, delicate, cellular tissue, which Spring considers to be the channel through which the sap circulates, and the seat of growth in the stem,—the inner portion being developed into wood vessels, and the outer into “liber.” The “liber” is composed of elongated cells, with thickened walls. Spring gives to it this name because of its analogy to the liber in dicotyledons. This layer is often so thin that it is difficult to detect. It is surrounded by a thick greenish layer, composed of large elongated cells, with thin walls; and this is covered with an epidermis, consisting of small cells with thick walls. The vascular bundles pass through the various layers of cellular tissue from the axis to the circumference.

The great difference between the stem of *Lepidodendron* and *Lycopodium* is the existence of a pseudo-medulla, and the arrangement of the vascular tissue as a solid cylinder in the fossil genus, compared with the central position and loose structure of the vascular tissue in the recent plant. In both the recent and fossil stems, the vascular tissues are surrounded by a zone of thin-walled cells, which has disappeared in all the dried specimens of *Lycopodium* I have examined, leaving the axis free, and which, as we have seen, is very rarely preserved in *Lepidodendron*.

Calamites.—Few fossils have been more misunderstood than the set of plants to which the name *Calamites* is given. One of the least errors regarding them was that which placed the stem upside down, and made the cylindrical roots its leaves. *Calamites* is rarely preserved so as to exhibit structure, being almost always converted into amorphous coal, and exhibiting an apparently furrowed and jointed stem, somewhat resembling the recent *Equisetaceæ*. The few specimens that have been found with the internal organization of the stems preserved, show a structure different from what had been assumed to be that of *Calamites*, and have been constituted into the genus *Calamodendron*. Like *Lepidodendron*, *Calamites* must have been a very brittle plant, as its remains occur in such a fragmentary condition, that great difficulty has been experienced in determining the different parts of the plant. The branchlets and foliage have been referred to the genus *Aspterophyllites*, supposed to be independent aquatic plants, and the fruits form the genus *Volkmania*.

The stem of *Calamites* was formed on a different plan from that of

Lepidodendron. Mr. Binney is at present engaged in preparing an account of its internal structure, with copious illustrations, which will be more complete than any hitherto published, because of the abundance of well-preserved specimens contained in his cabinet, the result of so many years' devotion to the study of the fossils of the coal measures. I shall therefore content myself with a hasty sketch of the genus. The specimens hitherto figured by Petzholdt, Corda, Göppert, Sternberg, Unger, and others, have generally wanted the cellular tissue of the axis and of the epidermis. The specimens which Mr. Binney has shown me exhibit, as I believe, the whole structure from the centre to the circumference. The axis (t. 55) consists of a considerable mass of cellular tissue without any vascular bundles penetrating it. This is surrounded by a solid cylinder of wood, formed entirely of scalariform vessels, and without (in all the specimens I have examined) any trace of medullary rays. The vascular tissue was developed from a series of equidistant points near the circumference of the cellular tissue, and grew outwards and laterally until they united in a continuous cylinder, fluted on the inner surface, and with the flutings filled with the cellular tissue of the axis. The early vascular bundles in the young stems of exogenous plants have a similar origin, but they speedily unite to form a woody cylinder, with a clearly defined and smooth inner surface towards the pith. This early condition is permanent in the stem of some arborescent species of *Cactus*, which, in this respect, closely resembles *Calamites*; but it is only a similarity in the arrangement of the parts, without any true affinity, for the stems differ as much as *Lepidodendron* does from *Cycas*. The woody cylinder formed constrictions at regular intervals round the cellular axis, as in some recent *Artocarpæ*. Beyond the woody cylinder there was a thin epidermal layer of parenchyma, which is less seldom preserved than even that of the interior.

The flutings and constrictions of the stem described as external were on the interior of the woody cylinder. The parenchyma having generally disappeared in fossilization, the wood alone formed the thin layer of coal that is generally all that remains to indicate the existence of the fossil. This is always furrowed longitudinally, and barred at intervals, apparently externally; but the examination of specimens, in which the structure is preserved, show that there was no fluting on the outer surface. Richter and Unger, in their 'Palæontologie des

Thüringer Waldes' (Vienna, 1856), have restored the stem of a *Calamites* with a thick epidermal cellular layer, and this they have furrowed on its outer surface; but as this layer was so perishable that it has almost invariably disappeared, it could not have produced the furrows which occur in almost every specimen. When the stems were thrown down, the cellular portions were generally completely decayed, and the space occupied by the axis was filled with the clay or sand in which the plant finally rested. In this way a cast of the interior was made, which in time became harder than the vascular tissue of the stem, and the pressure of the superincumbent deposits flattened and compressed the woody cylinder, producing on its upper surface a counterpart of the internal cast, with its furrows and constrictions. The furrows vary in size and closeness in different specimens, and produce indications sufficient to account for the different species that have been established.

The stem somewhat rapidly contracted at the base, the nodes shortening and giving off long cylindrical roots which spread laterally through the soil.

The main stem was simple, but at intervals gave off whorls of slender branches, and these again bore branches or leaves also arranged in whorls. The leaves were linear-acuminate, and each whorl contained from ten to twenty leaves.

The fruit (t. 56, f. 7) was composed of whorls of scales alternating with, and protecting whorls of sporangium-bearing spines (t. 56, f. 9). It was borne either at the termination of the primary branches or in whorls around them, and was composed of a shortened axis, with the leaves specially developed. The strobilus described by Ludwig (Meyer's 'Palæontographica,' vol. x. p. 11, t. 2), consists of from twenty to twenty-five series of barren protecting scales, arranged fifteen in a whorl, the scales of each whorl being opposite to those in the others. Between the scales is a whorl of five short spines, each supporting four flask-shaped sporangia. The spines of one series are arranged opposite to the spines of the other, that is to say, they are arranged perpendicularly on the axis, the one directly over the other. I have confirmed these observations on specimens of the fruits found in Britain, belonging to Dr. Hooker, and made some important additional observations on the structure of the strobilus and the contents of the sporangia, which I hope soon to publish.

It is not easy to find anything analogous to *Calamites* among recent

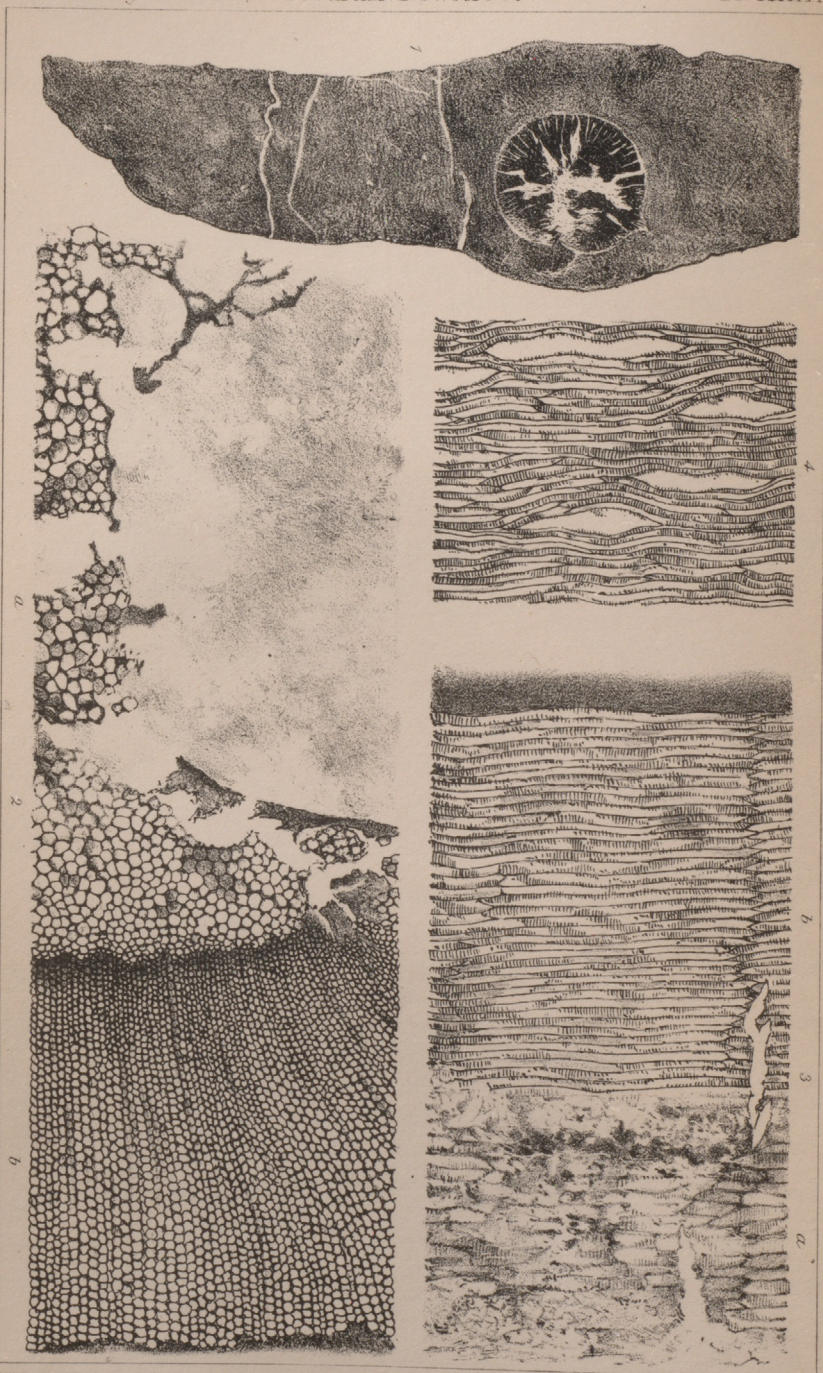
plants. Nevertheless, its structure does not differ so essentially from the vascular cryptogams as to cause any uncertainty as to its position. The histological character of its wood, the absence of medullary rays, and the nature of its fruit, clearly establish that it was a true cryptogam; and while it differed in the arrangement of the parts of its stem in its foliar appendages, and in its organs of fructification from *Lepidodendron*, yet it is evident these were both near allies, and both more highly organized than any of their living representatives.

EXPLANATION OF PLATES LV. AND LVI.

PLATE LV.—Restoration of *Lepidodendron* and *Calamites*; and section of stem of *Calamites*, showing the position of the flutings. (The axis is drawn too slender in proportion to the thickness of woody cylinder.)

PLATE LVI.—Figs. 1-5. *Lepidodendron*.—1. Transverse section of the half diameter. 2. Longitudinal section of ditto. 3. Strobilus. 4. Scale and sporangium. (The vascular bundle should be produced to the apex of the scale.) 5. Spores. Fig. 6. Scale of *Flemingites*. Figs. 7-12. *Calamites* (after Ludwig). 7. Strobilus. 8. Part of a whorl of strobili. 9. Longitudinal section of two cells of a strobilus. 10. Transverse section of one cell. 11. Apex of a spine with its four sporangia. 12. Scales from strobilus.

17



W.G. Smith, anal. nat. del.

Ulodendron minus, Lindl. & Hutt.

W. West imp.

I.—On the Structure of the Stems of the Arborescent Lycopodiaceæ of the Coal-Measures (*Ulodendron minus*, Lindl. and Hutt). By WM. CARRUTHERS, F.L.S., F.G.S., Botanical Department, British Museum.

PLATE XXXI.

THE genus *Ulodendron* was established by Lindley in the "Fossil Flora" for a group of Lepidodendroid stems, which, besides the rhomboidal leaf scars arranged spirally on the stem as in *Lepidodendron*, had deep oval or circular cavities ranged in two vertical rows on opposite sides of the trunk. Several species have been recorded, all of them from the Coal-measures. Professor Morris, in the last edition of his Catalogue of British Fossils, gives the names of seven species; but some of these must be reduced to synonyms. Belonging to the same group are two other forms which have received generic designations, but which should be placed, I believe, in this genus. These are *Megaphyton* and *Bothrodendron*: the only character which distinguishes the latter genus from *Ulodendron* is the obliquely oval form of the vertical scars. *Megaphyton* is based upon amorphous casts of a portion of the interior of the stem of *Ulodendron*. The series of scars represent the cavities, through which the vascular bundles to the vertical appendages passed, as they existed on the inner surface of the

EXPLANATION OF PLATE XXXI.

- FIG. 1.—Transverse section of a little more than half of the flattened stem of *Ulodendron minus*, Lindl. and Hutt., showing the scalariform axis—natural size.
- " 2.—Transverse section of a portion of the axis. *a.* the large irregularly-arranged scalariform vessels of the interior. *b.* the smaller radiating scalariform vessels of the investing cylinder. The tissues have been destroyed in the light-coloured portions, and the space filled in with carbonate of lime.
- " 3.—Longitudinal section of the same, lettered as in Fig. 2.
- " 4.—Longitudinal tangential section, showing the openings between the vascular bundles.

layer of elongated cells corresponding to that in *Lepidodendron selaginoides*, marked *e* in Figs. 1 and 2 of Plate XXVII.

The specimens of *Ulodendron* are most frequently casts in sandstone of the outer surface of the stem, or amorphous casts of the interior formed in the cavity left in the rock after the more or less complete decay of the original organism. Impressions of the scars are occasionally seen on the surface of the laminae in bituminous shales.

The specimen figured on Plate XXXI. is in the collection of the late Robert Brown, now in the Botanical Department of the British Museum. It has the label, "Coal Measures—Hemsford or Bradford—Rev. R. B. Cook, F.G.S., Doncaster." It is a fragment measuring $7\frac{1}{2}$ inches in length, 5 inches in breadth, and $1\frac{1}{4}$ inch in thickness. The surface is covered with the carbonized remains of the scale-like leaves arranged in a quincuncial manner. It is very much flattened, and exhibits three round conical pits characteristic of the species on each of its two edges. About two-thirds of the transverse section is shown at Fig. 1 of the natural size. The greater portion of the interior is composed of amorphous shale, but the tissues of the centre are more or less perfectly preserved. This forms a well-defined cylinder $\frac{8}{10}$ ths of an inch thick in diameter. It corresponds to the axis and surrounding cylinder of vascular tissue in *Lepidodendron selaginoides*, Sternb. (Plate XXVII., Figs. 1 and 2, *a* and *b*), and consists of similar tissues.

The transverse section (Fig. 1) shows that the inner portion is somewhat decayed; the cavities have been filled in with white crystallized carbonate of lime. Sufficient of the original tissue, however, remains to show clearly what it was. In the enlarged portion (Fig. 2 *a*) it is seen to be composed of vessels of different sizes, and of a circular or polyhedral form in transverse section. They do not appear to be arranged as I have described them in *Lepidodendron selaginoides*. The larger vessels are found in the interior, and amongst them a number of smaller vessels are irregularly intermixed. Towards the circumference the vessels are uniformly smaller, but they do not alter their form, being as nearly circular as those of the interior. In longitudinal section (Fig. 3 *a*) they are seen to be scalariform vessels. Their apparent shortness in the drawing arises from the direction of the section exhibiting a somewhat oblique cut through the vessel, and not from their actual terminations being seen.

The axis is surrounded by a cylinder of radiating scalariform tissue (Figs. 2 and 3 *b*). At its inner margin the diameter of the vessels composing it are small—their size increases outwards. I have not been able to detect any structure in this cylinder besides the scalariform vessels. The radiating lines are frequently separated by portions of calcite containing no organic structure. None of

these spaces occur in the portion enlarged at Fig. 2 *b*, which was accurately drawn with the aid of the camera lucida. In the longitudinal section (Fig. 4), made at right angles to the radius, several of these openings are shown. There is an apparent approach at regularity in their arrangement, which induces me to suppose that they may be the openings through which the vascular bundles passed to the leaves. They may, however, be only cracks produced in the desiccation of the tissues.

Beyond this cylinder no structure is preserved, until we reach the surface of the stem with the impressions of the leaves and the series of larger scars. The parts preserved agree so nearly in regard to the nature and arrangement of the tissues with what I have described in *Lepidodendron selaginoides* (Sternb.), that there cannot be any doubt as to the close affinities of these two stems. The structureless space represents the portion occupied with the delicate parenchyma, the more thickened and larger parenchyma beyond, and the elongated cells of the outer portion, together with the true bark. The proportion between the scalariform cylinder and axis and the external layers of parenchyma is the same in both stems. In the *Lepidodendron selaginoides*, figured on Plate XXVII. in the October number of this Journal, the cylinder measures $\frac{1}{4}$ th of an inch, and the whole stem is an inch in diameter, while in the *Ulodendron minus*, figured on Plate XXXI., the scalariform structures are $\frac{2}{3}$ ths of an inch in diameter, and the stem in its original cylindrical form measured 4 inches. The proportion of the axis in both is $\frac{1}{5}$ th of the whole stem.

For continuation see no. 19.

11

THE CRYPTOGAMIC FORESTS OF THE COAL PERIOD.

By WILLIAM CARRUTHERS, F.L.S., F.G.S., of the British Museum.¹

THE student of fossil botany encounters greater difficulties in his efforts to restore the vegetation of former epochs in the earth's history, than those which beset the labours of the comparative anatomist in his restoration of extinct animals. These difficulties arise chiefly from two causes: First, the absence in the vegetable kingdom of a substance which would resist decay like the solid skeleton found in all the vertebrate, and in many of the invertebrate members of the animal kingdom, causes the fragments of plants which have escaped decomposition to be preserved much less perfectly than the remains of animals. Carbonaceous stains or amorphous casts are the most frequent indications of the former vegetation of the globe; specimens exhibiting structure are comparatively rare; and it is such specimens only that give certain evidence of the nature and affinities of the organisms to which they belong.

The other serious source of difficulty arises from the fact that no relative proportions exist among the different parts of a vegetable individual. The size of the leaf, the flower, or the fruit, can give no indication of the size of the plant. Indeed, these are more frequently found large in humble plants which never rise above the surface of the ground than in large trees. And this is true, not only in the general, but even among members of the same natural group; where great differences exist in the size of the individuals, no corresponding differences are to be found in the parts of which they are composed. Thus the foliage and fruit of our only indigenous pine—the Scotch fir—are greater than those of the mammoth *Wellingtonia* of California; and the fruit of the small willow (*Salix herbacea*, L.), which covers with a dense carpet the summits of some of the higher mountains of Scotland, is as large as that of the huge willows which ornament the margins of our English rivers. On the other hand, the different parts of an animal possess such relations to each other in size, form, and

¹ Being the substance of a lecture delivered before the Royal Institution of Great Britain, at the Weekly Evening Meeting on Friday, April 16, 1869, Sir Henry Holland, Bart., M.D. D.C.L. F.R.S., President, in the Chair. The Illustrations have been kindly lent by the Council, together with permission to reprint this valuable contribution to Fossil Botany.—EDIT.

structure that a zoologist has not so difficult a task before him in restoring, even from imperfect materials, the general aspect of an extinct animal.

I state these difficulties which face us at the very threshold of our investigations, not to magnify the work before us this evening, but to account for the comparatively little progress that has been made in the interpretation of extinct floras, and for the great diversity of opinion that exists among botanists as to the systematic position of numerous fossil plants; and further to account for the very large number of genera and species which have been established on imperfect and fragmentary materials, the systematic position of which is consequently indeterminable.

The progressive accumulation of observations, and the more careful preservation of instructive specimens in local and private museums are supplying the means of dealing with fossil botany after a different method. The most important recent advances in this science have been made in uniting the separate fragments,—roots and stems, leaves and fruits,—described under different names and placed in different and often widely separated genera, so as to build up vegetable individuals, the systematic position and affinities of which can be understood.

These observations are specially true in regard to the vegetation of the Coal Period. Little information has been obtained from the vast stores of the carbonized remains of the plants of this period which are ever being brought under the inspection of man in the form of coal, for this material is so completely altered as to be almost destitute of structure. The best preserved plants occur in the beds of shale which accompany the coal, or are obtained from earthy nodules in the coal itself, which injure its marketable value, and are consequently got rid of by the miners.

We may at once set aside that great division of the vegetable kingdom with which we are most familiar, comprising all plants that have true flowers and seeds, and confine our attention to the more obscure cryptogamous plants which are destitute of flowers, and for seeds have bodies of much simpler structure called spores. The cryptogams are either wholly cellular in their composition, like the mosses and sea-weeds, or they are composed partly of cells and partly of vessels, like the ferns and club-mosses.

If we except some supposed *Algæ*, no traces of true cellular plants have been hitherto detected in the Coal-measures. The long-continued maceration to which the coal plants were subjected when the beds composed of their remains were forming on the surface of the earth, and the subsequent changes they have undergone, have reduced to one common structureless mass the varied vegetation of which the coal is composed. One of the first results of these operations would be the disappearance of the cellular plants, which under the then existing very favourable conditions must have abounded; just as the soft cellular parts are almost always destroyed of those specimens which have been so favourably situated as to have their vascular tissue preserved.

Excluding then the cellular cryptogams, we may shortly consider the classification and structure of the vascular forms. They are divided into four groups, all of which are represented in the indigenous Flora of Britain.

- I. Ferns (*Filices*). Polypody, Brake, Spleenwort, etc.
- II. Horse-tails (*Equisetaceæ*). Horse-tail.
- III. Club-mosses (*Lycopodiaceæ*). Club-moss and Quill-wort.
- IV. Pill-worts (*Marsileaceæ*). Pill-wort.

I. The FERNS have a rhizome which creeps below or upon the surface of the ground, or rises into the air like the trunk of a tree. This trunk in some species attains a great height; it is nearly uniform in diameter throughout its whole length, and is covered with the symmetrical and regularly-arranged markings of the stalks of the old leaves. Internally it is composed of a central cellular pith surrounded by a cylinder of scalariform tissue, and this is invested by a cortical cellular layer or bark.

The woody cylinder is composed of simultaneous vascular bundles, which originate and are completely developed at the same time; there is consequently no addition to it from subsequent growth. It is penetrated by large open meshes, each of which permits the passage of the vascular bundles that supply a leaf, accompanied with a certain amount of cellular tissue from the medulla which occupies the centre of the mesh.

The leaves, which are very variable in size and form, not only perform the functions of ordinary leaves, but also bear the fruit, and are hence called fronds. The fruit is produced in clusters on the back or margin of the fronds; each cluster contains many sporangia, and each sporangium numerous uniform spores.

Though there is a great diversity in the size of the plants of this order—from the humble Wall Rue to the giant *Alsophilas*,—there is a remarkable uniformity in the size of the spores.

When the spore germinates it bursts through the outer membrane and puts forth a tubular prolongation, which increases by cell-multiplication until a small green leaf is produced, called the prothallus, on the under-surface of which two kinds of glandular-like bodies are developed: the one, the antheridia, containing numerous cells with spermatozooids, the other, the pistillidia, one of which when fertilized develops into a true fern.

II. The HORSE-TAILS have slender, hollow, and jointed stems. Each joint terminates in a toothed membranous sheath, composed of leaves reduced to this elementary state. Whorls of branches and branchlets are given off at the joints in some species.

The fruit is produced in terminal cones composed of numerous stalked peltate scales, each of which bears on its under-surface a circle of sporangia filled with numerous uniform spores. The spores have a spiral covering, which, when they are ripe, breaks up into four clavate threads called elaters, which are remarkably hygrometric.

The spores germinate like those of ferns.

III.—The CLUB-MOSSES have solid stems composed of an axis of spiral vessels, surrounded by a thickish cortical cellular layer. The

leaves are simple, and arranged spirally on the stem. The branches are irregular and dichotomous.

The fruit is produced in terminal cones composed of imbricating scales. Each scale bears on its pedicel a small sporangium full of spores. In *Selaginella* two kinds of spores exist. The one, called microspores, produces spermatozoids; the other, macrospores, germinates, and forms a prothallus on which pistillidia appear; and these, when fertilized by the spermatozoids of the microspores, grow into perfect plants. In *Lycopodium* microspores only have been seen, and the process of its germination is still unknown.

The little Quillwort (*Isoetes*) which grows at the bottom of most of our mountain lakes, agrees with *Selaginella* in having two kinds of spores; but it differs from the true club-mosses in its habit and in the structure of the stem. Like *Welwitschia* it never increases in height; but this is even more remarkable in the Quill-wort than in *Welwitschia*, seeing that in it there is, as long as the plant lives, a continual development of nodes with their foliar appendages going on. The axis of the stem is composed of cellular tissue. This is surrounded by a vascular cylinder, which grows, as in exogens, by the addition of external layers, there being in this plant a true cambium layer outside the wood, a structure unknown in other cryptogams.

IV. No plants allied to the PILLWORTS have hitherto been detected in the Coal Measures; we need not, therefore, be detained by an examination of their structure and development.

In examining the palæozoic cryptogams of the Coal Forests, I will follow the same order as that in which we have glanced at their living representatives.

I. The FERNS need not long occupy our attention. They were very abundant, though as a rule they were humble herbaceous plants. Arborescent stems are extremely rare—only two undoubted species have been met with in Britain. The numerous known forms have either grown on the earth, or, as is very probable, been Epiphytes. Fructification is rare; in the few cases in which it has been found it agrees with that of recent ferns. Occasionally young fronds exhibiting circinnate vernation have been met with, showing that this method of unrolling the frond was as characteristic of the ferns of that period as it is of those of the present.

The fern is a remarkably stable type of vegetation. The earliest forms, like the *Cyclopteris Hibernica* of Forbes from the Old Red Sandstone, agrees in all comparable points with the recent plants; and throughout all the intervening space no divergence in any point of importance has been detected.

II. No group of fossil plants can more fully illustrate the imperfect materials with which the palæontological botanist has to deal than that group which I have united under the name *Calamites*.¹ The various parts of the plant—the root, the stem, the leaves, and the

¹ On the Structure of the Fruit of *Calamites*. Seeman's Journal of Botany, vol. v. (1867), p. 349, Pl. 70.

fruit—have been formed into numerous genera, which have been referred to widely different positions in the vegetable kingdom.

Considerable diversity of structure is to be found in those stems which are referred to *Calamites*. I shall ask your attention to one of these forms which I have described,¹ and which is beautifully illustrated by a series of drawings, recently published, of specimens in Mr. Binney's collection.² This stem was composed of a central medulla surrounded by a woody cylinder, composed entirely of scalariform vessels and a thin cortical layer. The medulla penetrated the woody cylinder by a series of regular wedges, which were continued, as delicate laminae of one or two cells in thickness, to the cortical layer. The cells of these laminae were not muriform; their longest diameter was in the direction of the axis. The wedges were continuous and parallel between each node. As the axial appendages were produced in whorls, the only interference with the regularity of the tissues was by the passing out through the stem at the nodes of the vascular bundles which supplied these appendages. As the leaves of each whorl were (with one or two exceptions) opposite to the interspaces of the whorls above and below, there was also at each node a re-arrangement of the wedges of vascular and cellular tissues.

The stem is described as having been fluted on the outer surface. This error had its rise in the specimens examined, being only casts in the amorphous substance of the rock of the medullary cavity, surrounded by a thin film of coal representing the cylinder of wood. On the death of the plant, the cellular medulla decayed, while the woody cylinder was still able to retain its original form. The hollow interior was filled with some of the mud or sand in which the plant was buried. In the course of time this offered greater resistance to the pressure of the beds above than the originally hard cylinder of scalariform tissue, now softened by the moisture in which it had so long lain: the more indurated amorphous axis on pressure necessarily produced its characteristic ridges and furrows on the smooth outer surface of the film of coal. This coal is described as the cortex or bark, and stems exhibiting only the rocky casts of the medullary cavity are called decorticated specimens; but, besides the cortical layer, they have also been deprived of all that remained of their woody tissue.

The stem terminated below somewhat suddenly in a blunt cone, the internodes of which were slightly developed; and from the nodes were given off whorls of large roots, which again gave off innumerable branching rootlets (*Pinnularia*).

The stem or main axis was simple, supporting numerous branches arranged in whorls, which again produced numbers of whorled leaves. Three different forms of leaves have been formed into as many genera. When the structure of the fruits associated with them is better known, by the discovery of better preserved specimens, it is possible they may be found to constitute three genera, but there are no characters

¹ On the Structure and Affinities of *Lepidodendron* and *Calamites*. Trans. Bot. Soc. Edin. vol. viii. (1866) p. 495, Pl. 8 and 9.

² On the Flora of the Carboniferous Strata, Part I. By E. W. Binney. Palæont. Soc. vol. xxi., 1868.

possessed by the leaves which prevent them belonging to one well-defined genus.

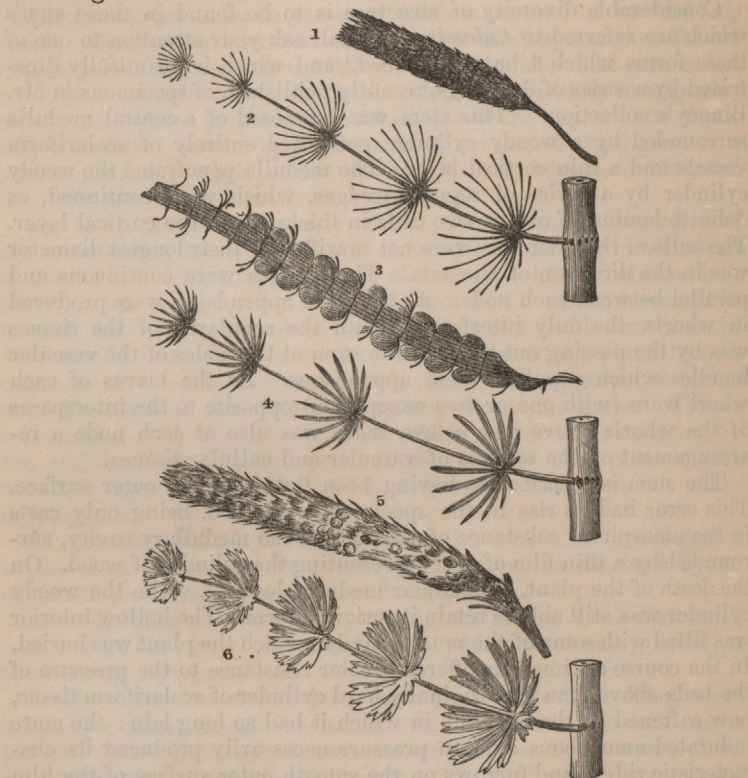


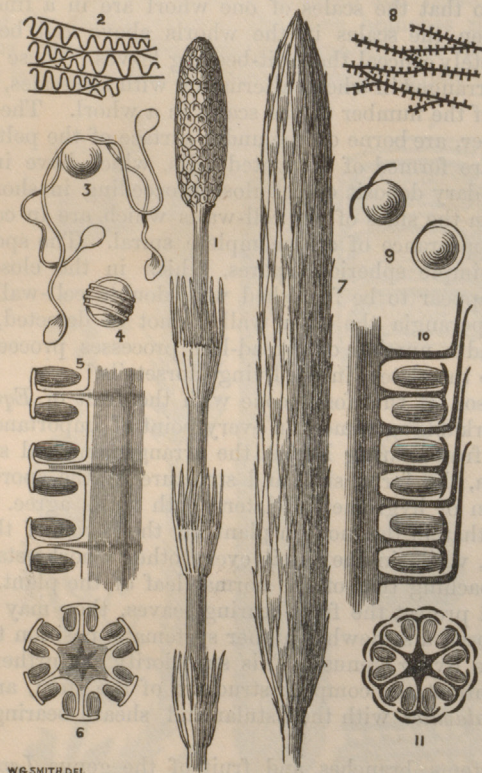
PLATE I.—FOLIAGE AND FRUITS OF CALAMITES.

1 and 2, *Asterophyllites*; 3 and 4, *Annularia*; 5 and 6, *Sphenophyllum*.

The simplest form of leaf (*Asterophyllites*) is slender and linear, with a single nerve. This can scarcely be separated from the form to which the name *Annularia* has been given, and which differs chiefly in having a larger amount of cellular tissue spread out on either side of the midrib. This form has a different aspect in the fossil state from the other, for its whorls of numerous broad leaves are spread out on the surface of deposition, while the acicular leaves of *Asterophyllites* have penetrated the soft mud, and are generally preserved in the position they originally occupied to the supporting branch. The third form (*Sphenophyllum*) consists of whorls of wedge-shaped leaves with one or more bifurcating veins. They occur like those of *Annularia*, spread out on the surface of the shale.

The plan of arrangement of the three forms is the same, and fruits are found associated with them which have the same general appearance; but they are so ill preserved that their internal struc-

ture has not hitherto been determined. The different forms have been placed together as allied genera, and have been referred, by those who have specially studied them, to the phanerogamous Order *Haloragaceæ* near to the Water Milfoil (*Myriophyllum*), with some species of which they agree very remarkably in the arrangement and aspect of their foliage and fruit.¹



W.G. SMITH DEL.

PLATE II.—FRUITS OF EQUISETUM AND CALAMITES.

Fig. 1. *Equisetum arvense*, L. 2. Portion of the sporangium wall. 3. Spore, with the elaters free. 4. Spore with the elaters clasping. 5. Longitudinal section of the part of one side of cone with three fruit-bearing scales supporting sporangia. 6. Transverse section of cone. 7. *Calamites* (*Volkmannia*) *Binneyi*, Carr., magnified three times. 8. Portion of the sporangium wall. 9. Two spores, one showing the bases of two elaters free, the remainder being removed in slicing the fossil, and the other showing the elaters clasping. 10. Longitudinal section of part of one side of cone with three fruit-bearing and four simple leaves. 11. Transverse section of cone, showing six fruit-bearing leaves and twelve protecting scales.

The determination of the internal structure of one of these fruits which I made, first from specimens collected by Mr. Binney, and have since confirmed from specimens which have been some years

¹ Monographie des Sphenophyllum d'Europe. Par E. Coemans and J. J. Kickz. Bulletin Acad. Roy. de Belgique, 2nd Ser. vol. xviii. (1864), No. 3.

in the cabinet of Dr. Millar, has enabled me to refer these fossils with certainty to the cryptogamous Order *Equisetaceæ* as near allies of our living Horsetails.

This fruit, to which I have given the name *Vollkmania Binneyi*,¹ is a small slender cone, composed of whorls of imbricated scales (twelve in each), arranged like the successive whorls of leaves on the branch, so that the scales of one whorl are in a line with the spaces between the scales in the whorls above and below. The scales completely conceal the fruit-bearing leaves. These are stalked and peltate, arranged in whorls alternating with the scales, but having only six—half the number of the scales in a whorl. The sporangia, four in number, are borne on the under-surface of the peltate leaves; their walls are formed of elongated cells, which have in their interior a secondary deposit of cellulose proceeding in short truncate processes from the sides of the cell-walls which are in contact, and having the appearance of an incomplete spiral. The sporangia are filled with simple spherical spores, which in the closely-packed sporangium appear to be furnished with double cell-walls. In the half-empty sporangia the outer wall cannot be detected, but there appear instead a number of thread-like processes proceeding from the spore like the elaters in the living Horsetails.²

A comparison of this fossil cone with the fruit of *Equisetum* exhibits a remarkable agreement in every point of importance. In the form of the fruit-bearing leaves, the arrangement and structure of the sporangia, the form, size, and structure of the spores, even to the possession of hygrometric elaters, both fruits agree. The only difference is that in the modern plant all the leaves of the cone are fruit-bearing, while in the fossil every other whorl retains a form closely approaching that of the normal leaf of the plant. As these envelope and protect the fruit-bearing leaves, they may be held to give to the fossil a somewhat higher systematic position than is possessed by the living genus. This superiority is further exhibited when we contrast the complex structure of the stem, and the free leaves of *Calamites* with the fistular and sheath-bearing stems of *Equisetum*.

III. The stems, branches, and fruit of the genus *Lepidodendron*, are so abundant in the shales that cover the coal, that the external aspect of this tree has been for a long time well known. Specimens exhibiting structure are more rare, but these also have been met with, so that we know the internal organization as well as the external aspect of the fossil.³

The stem is composed of a central pith surrounded by a slender cylinder of scalariform woody tissue, and by a large cortical layer

¹ Prof. Schimper has more recently described and figured the same fruits under the name of *Calamostachys Binneyana* in his *Traité de Paléontologie Végétale*, vol. i. (1869), p. 330.

² Mr. Binney has beautifully illustrated the structure of the stem and fruit of *Calamites* in a series of drawings from specimens in his rich collection, published by the Palæontographical Society in the end of last year.

³ On some Fossil Plants, showing structure. By E. W. Binney. *Quart. Journ. Geol. Soc.* vol. xviii. (1862), p. 106, Pl. 4—6. *Phil. Trans.*, 1865.

which is divided into two portions, an inner consisting of large spherical and thin-walled cells, and an outer made up of regularly arranged elongated cells with a small diameter. The vascular cylinder is penetrated by radiating meshes through which the vascular bundles passed that supplied the leaves. The outer surface of the stem is covered with the spirally arranged and beautifully marked stigmata of the fallen leaves. The stem branches repeatedly in a dichotomous manner. The younger branches are densely covered with small lanceolate leaves, having a single median vein.

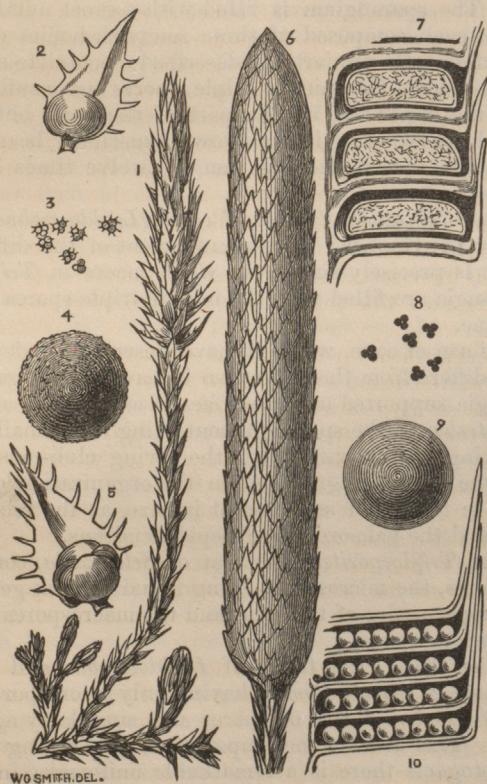


PLATE III.—FRUITS OF SELAGINELLA AND TRIPLOSPORITES.

Fig. 1. *Selaginella spinulosa*, A. Braun. 2. Scale and sporangium from the upper portion of the cone. 3. Antheridial microspores from ditto. 4. Macrospore. 5. Scale and sporangium from the lower part of the cone containing macrospores. 6. *Triplosporites Brownii*, Brongn. 7. Three scales and sporangia of ditto. 8. Microspores from the sporangia of the upper part of the cone. 9. Macrospore from the sporangia of the lower part (drawn from Brongniart's description and measurements). 10. Scales and sporangia of a cone of *Flemingites*.

The fruit is a cone composed of imbricated scales arranged spirally on the axis like the true leaves, and bearing the sporangia on their

horizontal pedicels. Three different forms of fruit belong to this genus, or it should perhaps rather be called group of plants.

The first of these is the cone named by Robert Brown *Triplosporites*,¹ and described by him from an exquisitely preserved specimen of an upper portion, in which the parts are exhibited as clearly in the petrified condition as if they belonged to a fresh and living plant. The large sporangia have a double wall, the outer composed of a compact layer of oblong cells placed endwise, or with the long diameter perpendicular to the surface; the inner is a delicate cellular membrane. The sporangium is filled with a great number of very small spores, each composed of three roundish bodies or sporules. Recently Professor Brongniart has described a complete specimen of this fruit,² in which the minute triple spores are confined to the sporangia of the upper and middle part of the cone, but the lower portion, which was wanting in Mr. Brown's specimen, bears sporangia filled with simple spherical spores ten or twelve times larger than the others.

The structure of another form of cone (*Lepidostrobus*) has been expounded by Dr. Hooker.³ The arrangement of the different parts comprising it is precisely similar to what occurs in *Triplosporites*; but the sporangia are filled with the minute triple spores throughout the whole cone.

The third form of cone, which I have described under the name *Flemingites*,⁴ differs from the other two in having a large number of small sporangia supported on the surface of each scale; and it agrees with *Lepidostrobus* in the sporangia containing only small spores.

In comparing these fossils with the living club-mosses, one is struck with the singular agreement in the organization of plants so far removed in time, and so different in size, as the recent humble club-mosses and the palæozoic tree *Lepidodendrons*.

The fruit of *Triplosporites*, like that of *Selaginella*, contains large and small spores, the microspores being found in both genera on the middle and upper scales of the cone, and the macrospores on those of the lower portion.

On the other hand, the fruits of *Lepidostrobus* and *Flemingites* agree with those of *Lycopodium* in having only microspores.

The size of the two kinds of spores also singularly agrees in the two groups. This is of some importance, for among the recent vascular cryptogams there is a remarkable uniformity in the size of the spores in the members of the different groups, even when there is a great variety in the size of the plants. Thus the spore of our humble Wall-rue is as large as that of the giant *Alsophila* of tropical

¹ Some account of *Triplosporite*. By R. Brown. Trans. Linn. Soc. vol. xx. (1851), p. 469, Pl. 33 and 34.

² Notice sur un fruit de *Lycopodiacees* fossiles. Par M. Brongniart. Comptes Rendus, vol. lxxvii., Aug. 17, 1868.—Translated in Seemann's Journal of Botany, vol. vii. (1869) p. 1.

³ On the Structure and Affinities of some *Lepidostrobi*. By J. D. Hooker. Memoirs of Geol. Surv., Vol. ii., Pt. 2 (1848), p. 440, Pl. 3-10.

⁴ On an Undescribed Cone from the Carboniferous Beds. GEOL. MAG., Vol. II. (1865), p. 433. Pl. 12.

regions. So also the spores of *Equisetum* and *Calamites* agree in size, as may be seen in Plate II., Figs. 3, 4, and 9, where the spores of the two genera are magnified to the same extent. And a similar comparison of the macrospore and microspore of *Triplosporites* with those of *Selaginella*, and of the microspore of *Lepidostrobus* with that of *Lycopodium*, exhibits a similar agreement. This is made apparent by the drawings of the two kinds of spores of *Selaginella* on Plate III., Figs. 3 and 4, with those of *Triplosporites*, Figs. 8 and 9, which are drawn to the same scale.¹

The fossils represented by the group of stems known under the name of *Lepidodendron*, and by the three fruits described, agree in all essential characters with the living Club-mosses, the only difference of importance being that the stem of the fossil has a higher organization suited to its arborescent habit. The vascular tissue continued to increase with the growth of the plant somewhat like an exogenous stem. In all the living vascular cryptogams, the vascular tissue is produced at once in its full extent except in *Isoetes*, which has a cambium layer surrounding the cylinder of wood in which as the plant grows new vascular tissue is developed. The zone of thin-walled spherical cells which surrounds the woody cylinder in *Lepidodendron*, and which is so rarely preserved, has been a true cambium layer like that in *Isoetes*. But for the existence of this small water-plant, the large trees of the coal-forests would present in the growth of their stems an inexplicable anomaly.

Sigillaria, a very abundant Carboniferous fossil, is a member of the same family as *Lepidodendron*. Its stem is rarely preserved so as to exhibit structure, the only specimen hitherto described being *S. elegans*, Brongn.;² but its roots are frequently found in a very perfect condition. The name *Stigmaria* was given to the roots at a time when they were supposed to be independent plants. Their relation to *Sigillaria* was suggested by Prof. Brongniart from the correspondence in their structure, by Sir W. Logan from the position the two fossils occupied in the beds in which they occur, and the matter was finally set at rest when Mr. Binney observed the roots and stems in actual continuity.

As the structure and arrangement of corresponding parts in the same plant are uniform, as of the root, stem, branches, and axis of the cone, we may supply the want of information regarding the stem by that which can be obtained from the root.

The root is composed of a central medulla surrounded by a cylinder of scalariform tissue, and this again is invested by a large cellular layer. The vascular cylinder is broken up by meshes through which passed the vascular bundles to the rootlets. There are no traces whatever of medullary rays in the wood. The supposed medullary rays which have been described in *Sigillaria* are the accidental results of desiccation in particular specimens. The internal structure

¹ I have given the precise measurement of these spores in a Notice of some Plant Remains from Brazil. GEOL. MAG., Vol. VI. (1869), pp. 153, 154.

² Observations sur la Structure intérieure du *Sigillaria elegans*. Par A. Brongniart. Archives du Mus., Vol. i. (1831) p. 405.

of the stem is precisely the same as in *Lepidodendron*, to which it is closely allied. Externally it has a very different appearance, being either a simple cylindrical column, or in some species dividing dichotomously into a few thick branches. The leaves are long, slender, and parallel-sided. Their scars ornament the older portions of the stem, on which they are arranged in perpendicular series with intervening furrows.

The fruit has been described by Goldenberg. It agrees with that which I have described in *Flemingites* except that the small sporangia are scattered in an irregular patch over the dilated base of an ordinary leaf, and this confirms the systematic position which I have given to *Sigillaria*.¹

The ferns and other genera which I have described may be considered the types of the plants to which we are indebted for our stores of mineral fuel. They grew in extensive level plains, their fleshy roots penetrating the soft mud which formed the surface soil, or the spongy layer of vegetable matter which covered it. The moist atmosphere (not at all likely to have been charged with more carbonic acid gas than that of our own day) would encourage the growth of cellular parasites and epiphytes, and the Aroid discovered by Dr. Paterson, with the several species of *Antholithes*, most probably represent races of epiphytes of a much higher organization than the cryptogamic trees on which they flourished.

Coniferous trees may have grown on the margins of the plain, but their proper habitat seems to have been the higher ground, from which an occasional stem was floated down by running water to the plains below. What plants were associated with the Conifers in those upland regions, is as yet quite unknown. The Flora of the coal period as at present ascertained is that of the plains. And this is of high interest, apart from the economic value of its products, because it reveals to the biologist an assemblage of plants agreeing in all essentials with some of the humble members of our present Flora, but attaining at so early a period in the history of the world a development not only in size but in organization, greatly in advance of their modern allies.

¹ For a lengthened examination of the affinities and structure of this genus, see a Memoir read to the Geological Society, at its meeting on March 24th, and to be published in its Quarterly Journal on the 1st of August next.

19



W.G. Smith F.R.S. scilicet nat. del.

W. West imp.

Fig. 1. *Ulodendron Taylori*, sp. nov. 2. *U. pumilum*, sp. nov.
3. *U. minus* Lindl. & Hutt. 4. *U. majus*, Lindl. & Hutt. 5-7. *U. tumidum*, sp. nov.

III.—*On the Structure of the Stems of the Arborescent Lycopodiaceæ of the Coal-measures.* By W. CARRUTHERS, F.L.S., F.G.S., Botanical Department, British Museum.

III. *On the Nature of the Scars in the Stems of Ulodendron, Bothrodendron, and Megaphytum; with a Synopsis of the Species found in Britain.*

(Communicated to the ROYAL MICROSCOPICAL SOCIETY by the PRESIDENT.)

(Continued from Vol. II., page 227.)

THESE genera are founded on stems which have large scars in longitudinal series on the two opposite sides of the stems. Of one of these the authors of the 'Fossil Flora' (plate lxxx.) said, many years ago, that "of all the anomalous forms that the Coal-measures have afforded traces this is perhaps the most remarkable." The various and very opposite opinions which have been, and still are, entertained in regard to them fully justify this statement. For several years my attention has been directed to the group, and during that time I have lost no opportunity of examining specimens in different collections in Britain. I have, besides, carefully examined a large series—most probably the largest anywhere to be found—in the British Museum. The interpretation which I have been led to adopt is somewhat different from that of my predecessors, but before explaining it and the data on which it rests, it will be well to give an historical sketch of the different opinions hitherto entertained.

The earliest notice of these fossils with which I am acquainted is by Steinhauer, in the 'American Philosophical Transactions' (vol. i., New Series, 1818), where he gives a very accurate drawing and description of *U. parmatum*. He cautiously considers that there is not sufficient data to form any satisfactory idea of the affinities

EXPLANATION OF PLATE XLIII.

- FIG. 1.—*Ulodendron Taylora*, sp. nov. Natural size. From a specimen from Bathgate, Linlithgowshire; in the British Museum.
- " 2.—*U. pumilum*, sp. nov. Natural size. From a specimen from the Yorkshire Coal-field, in the British Museum.
- " 3.—*U. minus*, Lindl. and Hutt. Section of the inverted cone of an aerial root in a sandstone cast of the stem, showing the depth to which the articulating surface penetrated the stem. From the collection of Ch. Peach, Esq.
- " 4.—*U. majus*, Lindl. and Hutt. Scar and leaves, natural size. From the cast of a specimen found near Swansea by Mr. Lucas; in the British Museum.
- " 5.—*U. tumidum*, sp. nov. Stem reduced one-third, showing the arrangement of the vascular bundles for the leaves, some patches of the carbonized remains of the bases of the leaves, and the swollen bosses from which the aerial roots sprang.
- " 6.—A patch of the carbonized remains of the bases of the leaves, natural size.
- " 7.—A cicatrix, natural size.

of the fossil, although he refers to the "curious resemblance that it has to that of some *Jungermannia* preparing for fructification, when highly magnified." Steinhauer includes under the same specific name a fragment of the stem of a Calamite exhibiting the large round scars of several branches, with the small and linear scars of the whorls of leaves. A similar fragment was afterwards figured in Lindley and Hutton's 'Fossil Flora' (plate cxxx.) under the name of *Cyclocladia major*. The scars of *Calamites* and *Ulodendron*, as I hope presently to show, were produced by similar causes; and it is a singular testimony to the accurate observation and enlightened views of the reverend author, which characterize his important memoir, that he united two objects that are apparently so different.

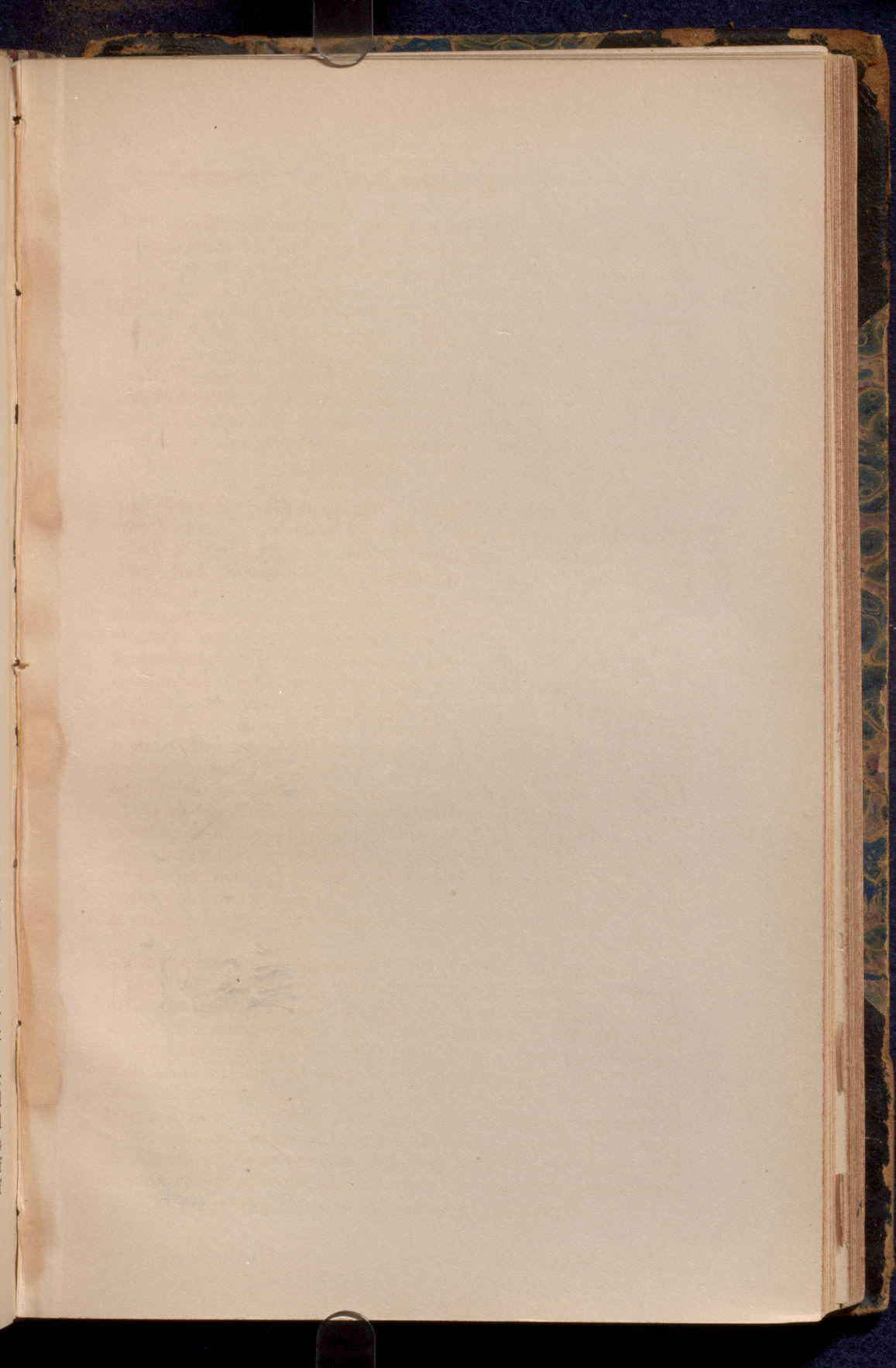
Rhode, in 1820, published, in his incomplete 'Beiträge zur Pflanzenkunde der Vorwelt' (plates iii. and vii.), figures of two forms of *Ulodendron*, and though he did not apply names to them, he entered into a long investigation as to the nature of their scars. In one species (*Ulodendron parmatum*) he held them to be the remains of flowers; and in a somewhat restored drawing, twice the natural size, of one of these scars, he gives it the aspect of small-petaled, oval, water-lily. This is perhaps not to be wondered at in an author who found the coal shales covered with impressions of the most highly organized flowers, preserved as if they had been laid out by a palæozoic botanist for his herbarium. His plates are greater curiosities than his specimens, and do no little credit to the liveliness of his imagination. The scars of his second species (*U. minus*, plate viii., figs. 1-3), inasmuch as they did not present any traces of petals, he held to be the cicatrices of fallen leaves.

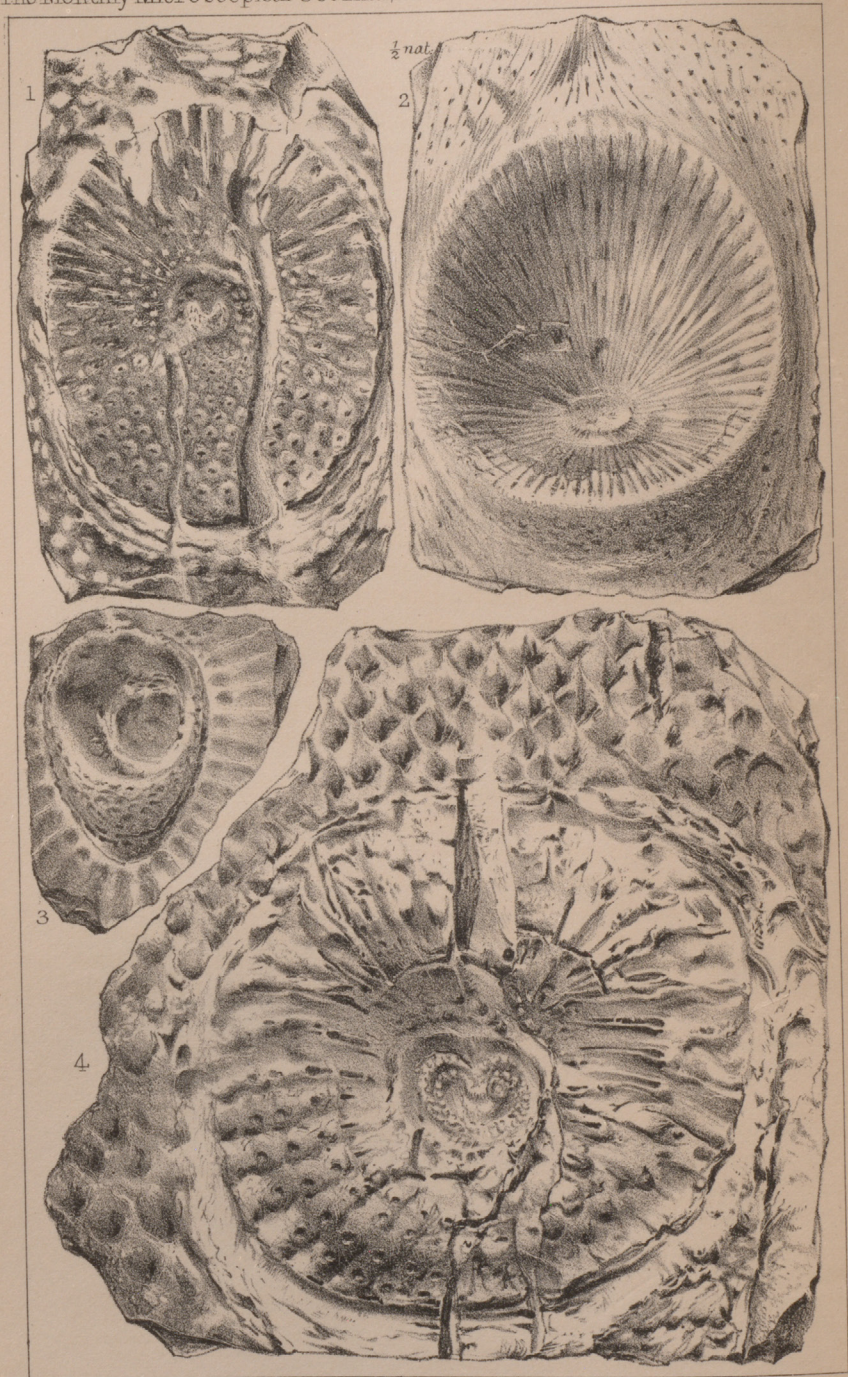
In 1823 Allan published* a figure of *U. parmatum*, from a finely-preserved cast found at Craighleith Quarry, near Edinburgh. The same specimen was subsequently figured by Buckland and by Brongniart, and I give on Plate XLIV., Fig. 4, a careful drawing of one of the scars. He did not venture on any decided opinion as to the nature of the scar.

Sternberg, in 1825, in the 'Tentamen Floræ Primordialis,' prefixed to his great 'Flora der Vorwelt,' gave the name of *Lepidodendron ornatissimum* to the first of Rhode's species, and, supposing that the scars resembled in some degree those on the trunk of arborescent ferns, he considered them to be the bases of leaves.

In 1831 Lindley and Hutton began the publication of their famous 'Fossil Flora,' and two of the early plates were dedicated to two specimens of *Ulodendron*—viz., plate v., *U. majus*, and plate vi., *U. minus*. They held that the scars indicated points from which had fallen off branches, or more probably masses, of inflorescence, consisting of closely imbricated scales like the cone of

* 'Trans. Roy. Soc. Edin.,' vol. ix., p. 235, plate xiv.





W.G. Smith F.L.S., ad nat. del.

W. West imp.

Fig. 1. *Ulodendron ovale*, sp. nov. 2. *U. transversum*, Eichw.
3. *U. Stokesii* Buckl. 4. *U. parmatum*, Carr.

Pinus. In their second volume they figured *Bothrodendron punctatum*, and the additional materials before them satisfied them that the cavities were the points of attachment of very large cones, which consisted of rounded polished scales three-tenths of an inch thick, attached to a central axis, and fitting accurately to each other. So completely did they resemble "such a strobilus as that of *Pinus Lambertiana*, that," say the authors, "we cannot doubt that the plant belonged to the natural order *Coniferæ*." And to this opinion they adhered at the close of their serial publication, for in the letter-press to plate ccxviii., which they considered the same as *B. punctatum*, they say they have nothing to add to what they had already said.

Buckland, in 1836, figured what he believed to be five species of *Ulodendron*, referring them without hesitation to *Coniferæ*, and holding that the scars were the impressions of deciduous cones. In the centre of each scar there is a cavity indicating the place of attachment of the cone. The upper portion is marked with furrows, produced by pressure of the long radiating scales at the bottom of the cone. This pressure nearly obliterated the smaller rhomboidal scales of the bark in those parts where the furrows are deepest; on the lower portion of the scars the scales of the bark were but slightly modified by the pressure of the cones. The back scales under the cone have fallen off, and the surface exhibits small apertures or tubular cavities, through which vessels entered from beneath the bark scales into the trunk.

Presl, in 1838, in Sternberg's 'Flora' (p. 185), considered the scars to represent the bases of branches, and referred the genera *Ulodendron* and *Megaphytum* (which he thought scarcely deserved to be retained as separate genera) to *Lycopodiaceæ*.

In his 'Prodrome' (1828), Brongniart, following Sternberg, placed Rhode's plant in *Lepidodendron*, but in the fragment of the second volume of his great 'Histoire des Végét. Fossiles' (1837), he places the three genera included in the title of the

EXPLANATION OF PLATE XLIV.

- FIG. 1.—*Ulodendron ovale*, sp. nov. Cicatrix of aerial root and leaf scars, natural size. From a specimen from the Edinburgh Coal-field, in the British Museum.
- " 2.—*U. transversum*, Eichw. Cicatrix of aerial root, and markings of the vascular bundles to the leaves, one-half the natural size. From a specimen from the South Wales Coal-field, in the Cardiff Museum.
- " 3.—*U. Stokesii*, Buckl. Scar of the compact bundle in the centre of the cicatrix of the aerial root. From a specimen from Halifax, in the British Museum.
- " 4.—*U. parmatum*, Carr. Cicatrix of the aerial root and leaf scars, natural size. From a cast taken from the natural sandstone cast; figured by Allan, and found at Craighleith, Edinburgh; now in the Museum of the Royal Society of Edinburgh.

present paper together in one group, considering that they probably differ only in the state of their preservation. He then enters into an investigation of the merits of Lindley's and Buckland's interpretation of the nature of the scar, and shows that the impressions on the under-half cannot be the scales of the stem, as they are arranged in a series peculiar to themselves, and different from that of the stem; and those on the upper part cannot be scars of cone scales, for they do not have the convex outer surface characteristic of all such scales. Unfortunately for the students of fossil botany, the 'Histoire' stopped at page 72, in the middle of a sentence, sufficient of which is printed to enable us to ascertain his critical objections to Buckland's views, but leaving untold his own interpretation of the nature of the scars. This loss is imperfectly remedied by the short note on the genus in his 'Tableaux des Germes Fossiles' (1849). Here he describes the scars as conical or hemispherical tubercles covered with foliar cicatrices, and prolonged in the centre into the beginning of a branch or adventitious root. His exposition is based on the beautiful specimen figured by Allan in the 'Edinburgh Transactions,' but he has overlooked the important fact that this specimen is a cast in sandstone of the outer surface of the stem, so that the elevated tubercles of the cast represented depressions in the original stem. He recognizes *Megaphyton* as a distinct genus allied to *Ulodendron*, and both forming a group near to *Lepidodendron*.

Göppert, in his 'Gattungen der Fossilen Pflanzen' (1841), figures a single scar, and considers it to belong to *Knorria*, and to represent in the central portion the point of attachment of a small branch, while the small scars are the bases of leaves arranged in relation to the branch—the interpretation afterwards given, as we have seen, by Brongniart.

Macalister, in a paper read to the Geological Society of Ireland (May, 1864), considered the fossil to be a cycadaceous plant, whose leaf scars were large and circular, and whose scales were as numerous and small as those of a *Lycopod*.

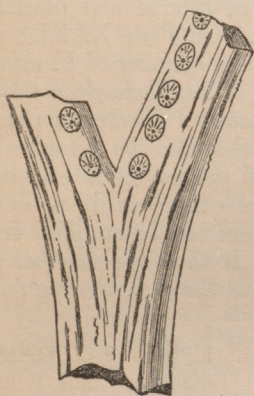
Dawson, in his 'Acadian Geology' (1868), refers *Ulodendron* and *Bothrodendron* to *Lomatophloios*, and says the scars "usually mark the insertion of the strobiles, though in barren stems they may also have produced branches; still the fact of my finding the strobiles *in situ* in one instance, the accurate resemblance which the scars bear to those left by the cones of the Red Pine when borne on thick branches, and the actual impressions of the radiating scales in some specimens, leave no doubt in my mind that they are usually the marks of cones; and the great size of the cones in *Lepidophloios* accords with the conclusion" (p. 456).

The genus *Megaphyton* he considers a tree fern, as the scars are not round and marked with radiating scales, but reniform or

oval, like those of tree ferns, and so are more probably leaf scars; while the small linear scars would indicate rammenta or small aerial roots. He accordingly restores it as an arborescent form bearing two large fronds, one on either side of the stem (p. 448).

The scar differs somewhat in form, being in some species circular, but in the majority more or less oval. It is always in the form of an inverted cone, though from the great pressure to which the stems have been subjected it is generally flattened. The actual depth is shown in a specimen of *U. minus*, found by Mr. C. Peach at Redhall Quarry, near Edinburgh, which is an amorphous cast in white sandstone of the outer surface of the stem. One of the pits of the natural size is represented in Plate XLIII., Fig. 3. The base or centre of the pit presents a scar of different form in the different species. In *U. parmatum* it has a double horse-shoe shape; in *U. Stokesii* it is a half-oval; in *U. Taylora* it is circular; and so on. The figure is formed by a number of small pits representing the number and position of the vascular cords which

supplied the supported organ. The remainder of the scar is covered with single pits, or radiating furrows arranged in symmetrical order around the basal scar. The pits are confined to the lower half of the scar, and the furrows to the upper half. That this is their true position has been already determined by the direction of the leaves when present, and by the form of their scars when they have fallen. I was enabled to establish it still more from the examination of an interesting dichotomously dividing stem in the collection of Daniel Ross, Esq., of Rockville, near Edinburgh, in which the position of the scars to the direction of the stem was clearly seen. There is



Dichotomously divided Stem of
Ulodendron parmatum.

not the slightest indication of scales in any of the large series of specimens I have examined. In attempting to make obvious what authors believed to be there, the drawings of *Ulodendron* frequently exhibit scale markings. Take, for example, the drawings of Allan's specimen of *U. parmatum* preserved in the Museum of the Royal Society of Edinburgh. The original drawing by Allan, though rude and turned upside down, is more accurate than Buckland's greatly reduced drawing* made from a plaster cast; or even than the original drawing by Brongniart, in his 'Hist. Vég. Foss.,' vol. ii., plate xxviii. In addition to examining the original specimen

* 'Geol. and Min.,' pl. lvi., fig. 3.

with great care, I took a cast of the whole of it, and several casts of the separate scars. From them the drawing of the scar on Plate XLIII., Fig. 4, has been faithfully produced by Mr. Smith. The original is a natural cast of the outer surface of the stem, whereas Mr. Smith's drawing is from the artificial cast, and consequently exhibits the true aspect of the outer surface of the scar. As is obvious, there are no scales; but the markings are all produced either by circular pits or by elongated furrows. These are the ends of the vascular bundles, as was determined by Presl and Göppert. The scar is bounded by a distinct boundary line, generally forming a raised margin, as in *U. parmatum*. This is certainly the boundary of the articulating surface, and shows that the smaller scars scattered over the large cicatrix were not the bases of leaves, as supposed by Göppert and Brongniart, but the bundles passing into a branch of some kind, as Presl suggested.

The difference in the form of the scars on the upper and under half of the stem which has puzzled observers, and has not yet been explained, will be obvious if we consider the structure of the stem on which these appendages were borne, as figured and described by me in former numbers of this Journal. On Plate XXXI.* was figured the structure of the axis and vascular cylinder of *U. minus*. A comparison of this drawing with that of *Lepidodendron selaginoides* on Plate XXVII. shows that the tissues of *Ulodendron* agree with those of *Lepidodendron* as far as they can be compared—and remembering that externally the two genera agree except in the possession of large scars by *Ulodendron*—there can be no doubt that the elementary tissues of the one stem can be supplied from the more perfect specimen of the other. It thus appears that the conical scar has passed far into, if not quite through, the regularly arranged prosenchyma of the circumference. The vascular bundles, rising upwards and outwards from the circumference of the vascular cylinder, would, in passing into the appendicular organ, penetrate the lower half of the articulating surface at right angles, and would consequently show as circular pits on the cicatrix; while the bundles on the upper half would penetrate the surface at a very oblique angle, and would consequently show on the cicatrix as more or less elongated furrows. This will be apparent by an examination of the accompanying diagram. In species, like *U. transversum*, where the inverted cone of the scar has a de-

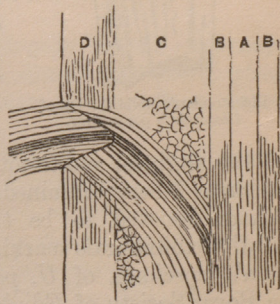


Diagram of the Stem of *Ulodendron*, showing the direction of the bundles entering the aerial roots. A, vascular axis; B, cylinder of scalariform vessels; C, parenchyma; D, prosenchyma.

* 'Monthly Microscopical Journal,' vol. i.

scending direction, the smaller will necessarily have a more or less furrowed aspect on the lower as well as on the upper half of the great scar.

It is remarkable that among the many specimens of *Ulodendron* that have been seen, none have exhibited the appendicular organ in its natural relation to the stem. Dr. Hooker says, Mr. Dawes showed him a specimen preserved in sandstone, with a large organ, which he considered to be a cone inserted into one of the cup-shaped depressions; but he was unable to form any conclusion concerning its real nature.* Had Principal Dawson rested his determination that scars were the impressions of the bases of cones on his having found one *in situ*, I must have concluded that his plant was very different from the European *Ulodendron*; but his illustration† agrees with the scars we have figured and described. We hope that a re-examination of the matter in the light of the additional facts and explanations contained in this paper, may lead the learned author to a different interpretation of the structure.

That the appendages were articulated to the stem by the whole surface of the scar cannot be doubted. In the want, however, of any observed specimen, it is not so easy to determine what these appendages were. The specimen figured on Plate XLIII., Fig. 5, appears to me to throw considerable light on the matter. In this species the opposite series of scars are borne on swellings on the stem, and the downward aspect of the scars shows that the organs which sprang from them had a descending direction. That this is the true position of the stem is abundantly established by the dark carbonaceous patches which here and there are attached to it, and which are the bases of the leaves converted into coal. One of these patches from the other side of the stem from that shown in the drawing is represented the size of nature at Fig. 6, and here it is seen that the bases of the leaves still remaining are imbricated over each other, and that the scars where the leaves were broken off are on the upper portion of each base. This clearly shows the natural direction of the specimen figured. The appendages, then, must have been adventitious roots in this specimen. In the light of this specimen, the form and direction of the scars where their original depth is to any extent preserved, appear to corroborate this view. The appendage could not in any of them have been patent; indeed, they seem to show that it must have passed out outwards and downwards.

The scars are not at all constant in the method of their arrangement. In *U. parmatum* I have seen a considerable fragment of the stem with only one well-formed scar upon it, the remainder being covered with rhomboidal leaf scars; in other specimens I have observed from eight to twelve scars, so closely approximated in

* 'Memoirs Geol. Surv. Great Brit.,' vol. ii., pl. ii., p. 427.

† 'Acadian Geology,' p. 457, fig. 170.

linear series that their adjoining margins touched, while in the bifurcated specimen figured on page 148, the lower and older portion is seen to be destitute of them, yet they appear on the two branches.

We know nothing of the upper portion of *Ulodendron*. It is very probable that the stems were repeatedly divided in a dichotomous manner, and that the branches, foliage, and fruit agree so nearly with those of *Lepidodendron*, that they have been referred to that genus. Hugh Miller, in an interesting paper "On some Fossils from the Edinburgh Coal-field," read to the Royal Physical Society, describes a specimen which, as it lay in the rock, exhibited a true branch shooting out at an acute angle from the stem, intermediate between the rows of scars. Unfortunately, the specimen was somewhat injured in lifting it from its matrix. It forms part of the Miller Collection now deposited in the Edinburgh Museum. On examination, I found that the leaf scars of the branch were arranged in a direction opposite to those on the stem, but this may have arisen from the fractured specimen having been incorrectly united.

Bothrodendron is universally referred now to *Ulodendron*. It was based upon a specimen from which the leaf bases and the outer portion of the stem (*f, g, h*, of Fig. 1, Plate XXVII.) had been removed, and instead of the more or less rhomboidal scars, the pits of the vascular bundles only are seen.

Megaphyllum is based upon casts of the interior of the stem against the inner surface of the regular prosenchyma of the stem (*e*, of Fig. 1, Plate XXVII.). The scar represents only the main central vascular bundle of the scar of *Ulodendron*, and has the same form in the different species as in the species of that genus. Thus *M. distans* agrees with *U. Stokesii*, and *M. approximatum* with *U. parmatum*. The interrupted striae which cover the stem between the rows of scars are the impressions of the meshes in the prosenchyma, through which the vascular bundles passed to the leaves. This view of these points is further established by the figure of *Megaphyllum approximatum* given by Lindley and Hutton, 'Fossil Flora' (plate cxvi.). In this plate a more external portion of the stem is seen on the upper left-hand corner of the specimen; and this shows the regularly-arranged dots characteristic of the condition to which these authors gave the name *Bothrodendron*.

Megaphyllum is related in the same way to *Bothrodendron* and *Ulodendron*, as *Knorria* is to the "decorticated" and "corticated" forms of *Lepidodendron*, and as the fluted casts of *Calamites* are to the smoother "corticated" forms.

Synopsis of the British Species.

Nat. Ord. *Lycopodiaceæ*.

Ulodendron, Lindl. and Hutt., 'Fossil Flora,' plate v. Stem covered with rhomboidal scars of leaves, and having large round or oval conical depressions arranged in linear series on opposite sides,

from which sprang aerial roots; leaves acuminate, with a median nerve. *Megaphyton*, Artis, 'Antediluvian Phytology,' p. 20. *Bothrodendron*, Lindl. and Hutt., l. c., plate lxxx.

1. *U. parmatum*, Carr. Large cicatrix oval, $3\frac{1}{2}$ inches long by $2\frac{1}{2}$ inches broad; central scar of the form of a double horse-shoe; leaf scars elongated-rhomboidal. *Phytolithus parmatum*, Steinh., 'Amer. Phil. Trans.,' vol. i., Ser. 2, p. 287, plate vii., fig. 1 (1818). *Lepidodendron ornatissimum*, Sternb., 'Flora Vorw.'—Tent., p. xii. (1825). *U. Allanii*, Buckl., 'Geol. and Miner.,' vol. xi., p. 92, plate lvi., fig. 3 (1836). *U. Rhodii*, Buckl., l. c., p. 93. *U. Conybearii*, Buckl., l. c., p. 94, plate lvi., fig. 6. *U. Rhodianum*, Presl, in Sternb., 'Flora,' p. 186 (1838). *U. ellipticum*, Presl, l. c., *Bothrodendron punctatum*, Lindl. and Hutt., plate ccxviii. (non lxxx. and lxxxi.). *Megaphytum approximatum*, Lindl. and Hutt., plate cxvi.

A scar of an aerial root and of some leaves is shown, natural size, on Plate XLIV., Fig. 4.

From the Coal-measures, Edinburgh, Newcastle, &c. [Edin. Roy. Soc. Museum, British Museum, &c.]

2. *U. Stokesii*, Buckl., 'Geol. and Miner.,' vol. ii., p. 93, plate lvi., fig. 5. Large cicatrix, shortly oval, or sub or bicular, $4\frac{1}{2}$ inches long by $3\frac{1}{2}$ broad; scar of the small vascular bundles somewhat elongated and radiating; of the central bundle, semi-ovate, very broad at the apex, with a free space in the centre; leaf scars elongated-rhomboidal. *Megaphytum distans*, Lindl. and Hutt., 'Fossil Flora,' plate cxvii. *M. Allanii*, Brongn., 'Hist. Végét. Foss.,' vol. ii., plate xxviii., fig. 5, most probably belongs to this species. The original of his figure is in the Museum of the Royal Society, Edinburgh.

A figure of the scar of the central vascular bundle is given of the natural size in Fig. 3, Plate XLIV.

From the Coal-measures, Newcastle. [British Museum.]

3. *U. ovale*, sp. nov. (Plate XLIV., Fig. 1). Cicatrices oval, $2\frac{1}{4}$ inches long by $1\frac{3}{4}$ inch broad; scar of the compact bundle in the centre small, roundish, slightly indented on the upper margin; scars of the separate bundles very numerous; depressed margin of the cicatrix with a single series of vascular bundles; leaf scars rhomboidal.

From the Coal-measures, Edinburgh. [British Museum.]

4. *U. pumilum*, sp. nov. (Plate XLIII., Fig. 2). Cicatrices oval, nine lines long by seven lines broad; scar of the central bundle roundish, nearly central; leaf scars crowded, and covering the stem, broadly rhomboidal, with a central depression marking the place of the vascular bundle.

From the Coal-measures, Yorkshire. [British Museum.]

5. *U. Taylora*, sp. nov. (Plate XLIII., Fig. 1). Cicatrices oval,

nine lines long by eight lines broad; scar of the compact bundle roundish; separate scars fewer than in *U. pumilum*; leaf scars distant from each other, with as much free space separating them as their own breadth, obovate, with decurrent base, and a scar, where the vascular bundle passed out.

I have associated with this species the name of an old class-fellow, Andrew Taylor, Esq., Edinburgh, who during the past summer led me to a quarry in the neighbourhood of Bathgate, where he observed remains of *Ulodendra*, and where we succeeded in obtaining specimens of this interesting species.

From the Coal-measures, Linlithgowshire. [British Museum.]

6. *U. transversum*, Eichwald, 'Lethæa Rossica,' vol. i., p. 139, plate ix. Cicatrices deltoid, with the angles rounded, nearly 4 inches long by $3\frac{3}{4}$ inches broad; scar of compact bundle near the base, of a flattened horse-shoe shape, separate bundles radiating all round from the cone of the aerial root descending into the stem; leaf scars rhomboidal. *Megaphytum majus*, Presl, Sternb., 'Flora,' p. 187, plate xli., probably belongs to this species.

A scar half the natural size is figured on Plate XLIV., Fig. 2. It belongs to a "corticated" specimen, and shows only the pits of the vascular bundles belonging to the leaves.

From the Coal-measures, Northumberland (Jarrow) [British Museum], and South Wales [Cardiff Museum].

7. *U. majus*, Lindl. and Hutt., 'Fossil Flora,' plate v. Cicatrices circular, $2\frac{1}{4}$ inches in diameter; scar of compact bundles central, compressed circular; scars of separate bundles more or less pit-like throughout; leaf scars rhomboidal. *U. Lucasii*, Buckl., 'Geol. and Miner.,' vol. ii., p. 93, plate lvi., fig. 4 (1836). *U. Lindleyanum*, Presl, in Sternb., 'Flora,' p. 185 (1838). *Bothrodendron punctatum*, Lindl. and Hutt., 'Fossil Flora,' plates lxxx., lxxxi. (excl. plate cxxviii.).

The scar figured, Plate XLIII., Fig. 4, is from a fine cast of a specimen found near Swansea by Mr. Lucas.

From the Coal-measures, South Wales, Northumberland, &c. [British Museum.]

8. *U. minus*, Lindl. and Hutt., 'Fossil Flora,' plate vi. (excl. synonymes). Cicatrices sub-circular, from $1\frac{1}{2}$ to $1\frac{1}{4}$ inch in diameter; scar of compact bundles triangular with the angles rounded; scars of the separate bundles pit-like on the under half, radiating and furrowed on the upper; leaf scars rhomboidal.

The drawings by Lindley and Hutton of the last two species are very unsatisfactory. I have never seen the cicatrices composed of large flat scales, as represented there.

From the Coal-measures, Northumberland, Edinburgh, South Wales, &c. [British Museum.]

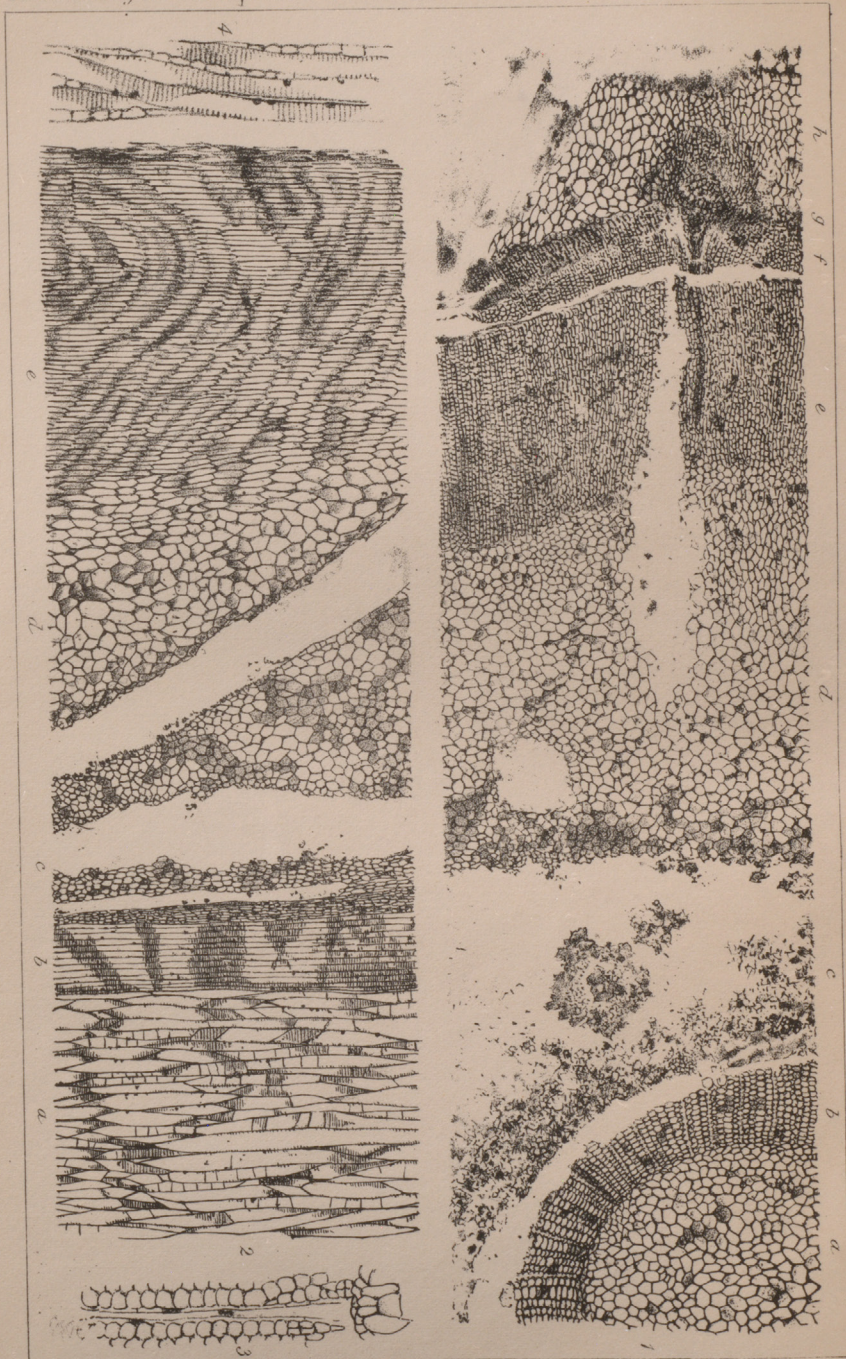
9. *U. tumidum*, sp. nov. (Plate XLIII., Figs. 5-7). Cicatrices small, oval, eight lines long by six lines broad, borne on tumid swellings on the opposite sides of the stem; solitary cicatrices scattered over the stem; scar of the compact bundle circular, of the separate bundles pit-like; few in number; leaves with a broad base imbricated.

Fig. 5 represents a portion of the specimen one-third the natural size; it has lost all indications of the bases of the leaves, except on one or two patches, one of which, from the surface not shown in the figure, is represented natural size at Fig. 6; and one of the cicatrices, natural size, in Fig. 7.

From the Coal-measures. Britain—locality unknown. [British Museum.]

Continued in next paper.

It is a very common mistake to suppose that the
only way to get the most out of a book is to read it
from cover to cover. This is not the case. The best
way to get the most out of a book is to read it
in a way that suits your own needs. For example,
if you are interested in a particular subject, you
may want to read the chapters on that subject first.
If you are interested in the author's life, you may
want to read the biographical chapters first. The
important thing is to read the book in a way that
suits your own needs. This will help you to get
the most out of the book.



W.G. Smith nat. del.

Lepidodendron selaginoides, - Sternb.

W. West imp.

I.—On the Structure of the Stems of the Arborescent *Lycopodiaceæ* of the Coal Measures. By W. CARRUTHERS, F.L.S., F.G.S., Botanical Department, British Museum.

(" Taken as Read " before the ROYAL MICROSCOPICAL SOCIETY, June 9, 1869.)
(Communicated by the President.)

PLATE XXVII.

HAVING for some time been collecting materials for the illustration of the stems of *Sigillaria*, *Lepidodendron*, and other forms of gigantic *Lycopodiaceæ* belonging to the Carboniferous period, I propose to submit to the Society some account of these remarkable structures, and to examine the points of agreement and difference between them and the stems of existing plants.

I have been especially fortunate in obtaining a large collection of fossils from the beds of volcanic ash discovered by E. Wunsch, Esq., in the north-east corner of the Island of Arran, in the Frith of Clyde. Guided by his son, I had myself the pleasure of exploring the beds and of collecting a number of specimens. The rocks are exposed on the shore at Laggan, and consist of a considerable series of volcanic tufas indurated by infiltrated carbonate of lime, alternating with thin beds of hardened shales. Stigmarian roots abound in the shales, and, with not a little difficulty, I removed the superimposed rock and traced the radiating branches of *Stigmaria* proceeding from a large trunk of *Sigillaria*. The different beds of shale formed the soil on which grew extensive cryptogamic forests, that were successively destroyed when in their prime by showers of volcanic ash, which broke down and buried in its mass the branches,

EXPLANATION OF PLATE.

- FIG. 1.—Transverse section of a portion of the stem of *Lepidodendron selaginoides*, Sternb., from the centre to the circumference. *a.* the axis. *b.* the investing cylinder, both composed of scalariform vessels. *c.* delicate parenchyma, more or less decayed. *d.* stronger parenchyma passing into prosenchyma *e.* *f.* outer layer of the prosenchyma. *g.* the bark. *h.* section through the decurrent base of a leaf.
- " 2.—Longitudinal section of ditto through the centre of the axis. The letters refer to the same structures as in Fig. 1. The open space above the letter *c* arises from the decay of the delicate parenchyma; that above the letter *d*, which passes upwards and outwards, was occupied by a vascular bundle and its associated delicate parenchyma.
- " 3.—One of the cellular rays in transverse section.
- " 4.—Section of several rays at right angles to their direction.

and left as bare poles the scorched and dead stems rising high above the ash as witnesses of the terrible destruction. In the course of time they were hidden by the growth of a luxuriant vegetation which speedily covered the new soil, but only to be destroyed by a fresh outburst from the intermittently active volcano in their neighbourhood. Frequently spores found a suitable nidus in the decayed and hollow interior of these immense stems. Mr. Wunsch has given me specimens, in which from six to nine young trees, with stems from two to three inches in diameter, belonging probably to several distinct species and at least to two genera, have grown by the side of each other within a single trunk. The fragments of the branches in the beds of tufa retain to a great extent their original form, and the minute structure is often preserved in a singularly perfect manner. In addition to the specimens I myself collected, I have been supplied in the most liberal manner by Mr. Wunsch with specimens collected by himself. I am also indebted to Mr. J. Young, of the Hunterian Museum, Glasgow, for some interesting specimens he obtained from the same locality.

Professor Morris has supplied me with several important specimens from the Lancashire coal-field. The grant placed at my disposal by the British Association has enabled me to have these various materials prepared by the lapidary, so as to be able to make the most exact microscopical examination of their structure.

In addition to these, I have had the use of several fine preparations from the cabinet of Dr. J. Millar; I have examined the valuable series of microscopic preparations recently acquired by the British Museum, made by Nicol (the inventor of the method of slicing fossils) and Bryson, and the yet more valuable collection made by Robert Brown, and bequeathed by him to the same institution.

The specimens exhibiting structure are generally in nodules in the coal. The conditions which were favourable to the accumulation and preservation of the plant-remains of the Coal period in a state of purity that makes them now invaluable to man, did not also favour the conservation of those characters which would enable us to determine the nature of the plants themselves. With the exception of the thin layers of charcoal, commonly called "Mother-coal," the origin of which has never been satisfactorily accounted for, the whole mass of vegetable matter was speedily reduced to a homogeneous and amorphous condition by decay, greatly assisted by the abundant water. The covering of plastic clay, now indurated into the shale, which invariably forms the "roof" of every good seam of coal, stopped the progress of decomposition, and sealed up the precious deposit against the intrusion of injurious substances like iron or lime. It is only where this cover has been insufficient to isolate the bed or has had in itself iron or lime, some of which it has parted with, that nodules are found in the coal, making the seam where they occur in quantity of less economic

value, but supplying to the naturalist the means to some extent of reading the life history of that period. By the mysterious power of selection and accretion which has formed nodules in sedimentary rocks, fragments of the tissue of the bed have been arrested in their decay, and converted into imperishable limestone. It is seldom that the preserving material has had access to the structures in time to preserve them in their entirety. The more delicate cellular tissue has generally been completely lost. The Arran specimens are remarkable exceptions to this state of things, and this is probably owing to the conditions under which they were buried. The hot ashes, which formed their tomb, appear to have completely charred them, and then, converted into charcoal, they resisted decay and pressure until every cell and cavity was filled by the infiltrated carbonate of lime which converted the loose ashes into a compact stone, and at the same time made permanent in its original form all the most delicate structure of the plant.

The specimen I select first for description is one from the cabinet of Dr. Millar, belonging to the type described by Mr. Binney under the name *Sigillaria vascularis*.* As the specimen belongs to *Lepidodendron selaginoides*, Sternb., I shall employ, in accordance with the invariable practice of naturalists, the older name in speaking of it. I have chosen this species because it is one that may easily be obtained by students. I have it from different localities, and Mr. Binney tells us that the Halifax Hard Seam or Ganister coal at South Ouram, near Halifax, contains in some places so many of the nodules as to render it useless—that they occur over a space of several acres, then almost disappear, but occur again as numerous as before,—and that this has been traced over a distance of twenty-five to thirty miles.

As the technical terms which I shall be obliged to use for perspicuity are somewhat different from those employed by Mr. Binney, there is the more necessity for redescribing this fossil; besides, I shall add some points which I have determined in my examination of the series of specimens which have passed through my hands.

The stem of the *Lepidodendron selaginoides*, portions of which I have figured on the Plate, is somewhat compressed, being 1 inch across its greater diameter and $\frac{3}{4}$ of an inch across its lesser.

The axis of the stem is composed of scalariform vessels of large diameter. In transverse section (Fig. 1a) it is seen to be composed of two parts—1st, a central portion, consisting of vessels of different sizes, more or less circular or polyhedral in section, and arranged in irregular order; and 2nd, an external portion, in which the vessels have an irregularly radiating direction, their longest diameter being

* "On some Fossil Plants showing Structure, from the Lower Coal-measures of Lancashire," by E. W. Binney, Esq., F.R.S. 'Quart. Journ. Geol. Soc.' vol. xviii., p. 106, Pl. IV. and V. The stems described under the same name in the 'Phil. Trans.' by Mr. Binney, are different, and are consequently not taken into account in the present notice.

in the line of the radius (this is not well rendered in the plate). The circumference of the axis is regular, from the interspaces between the large vessels being filled in by some of smaller diameter. The vessels are of considerable length (Fig. 2*a*), so that I have not been able to obtain a longitudinal section which would show with certainty both terminations of one. Some of those in the centre of the axis are divided into chambers by horizontal septa, or rather they appear to be made up of a series of short obtuse cells, whose transverse as well as longitudinal sides are marked with scalariform bars. Such interrupted vessels are scattered irregularly through the others. I can detect no trace of any other structure in the axis than scalariform vessels.

Surrounding the axis is a narrow cylinder of radiating scalariform tissue (Fig. 1*b*), differing from that of the axis only in the method of its arrangement, and in the smaller diameter of the vessels. They are seldom more than a quarter of the size of those of the axis, and are smallest at their origin in the interior of the cylinder. Their form in transverse section is sub-quadrangular. They are separated into groups of one, two, three, or four rays by a horizontal radiating structure composed of somewhat elongated cells with truncate ends, and delicate walls without any markings on them (Fig. 3). The cells are from two to four times longer than the diameter of the scalariform vessels of the cylinder, while their transverse diameter is only half that of their vessels. In a longitudinal section at right angles to the radius these cells are seen to be arranged either singly, in longer or shorter linear series, or occasionally in larger wedges composed of two or three cells in thickness (Fig. 4). In addition to this cellular structure there also are seen passing outwards, between meshes in the cylinder of scalariform vessels, bundles of similar but more delicate vessels connected with the leaves. Both these structures are described by M. Brongniart in his *Sigillaria elegans*. The first are his medullary rays. It is obvious that this term is scarcely admissible here, as the axis of the stem is not occupied with a cellular or medullary tissue, but with scalariform vessels. In a recent paper on *Sigillaria** I ventured to doubt that these were medullary rays, but I was not then able to show that whatever the structure is it cannot be interpreted as similar to that of the medullary system of dicotyledons.

The vascular cylinder is surrounded by a considerable thickness of delicate parenchyma (Figs. 1*c* and 2*c*), which in most specimens has completely disappeared, but in that figured some remains of it exist in the transverse section near the vascular cylinder, and a larger quantity is seen in the longitudinal section (Fig. 2*c*). The cells of this layer are small and spherical, with very delicate walls. They were the first portion of the stem structures to decay, and

* 'Quart. Journ. Geol. Soc.,' vol. xxv., p. 248.

almost invariably the cellular rootlets from Stigmarioid and other roots pushed their way into these decaying cavities, and being there preserved have been mistaken by several observers for portions of the tissues of the stem. The vascular bundles, described as penetrating the vascular cylinder, pass in an upward and then in an outward and upward direction through this layer of parenchyma. Frequently these delicate bundles have been involved in the decay which destroyed the mass of the cells through which they passed, and no record of them remains from their leaving the vascular cylinder until they enter the outer cylinder of more compact tissue. In the specimen figured I have counted twenty-four vascular bundles, either closely adpressed to or adjoining the vascular cylinder.

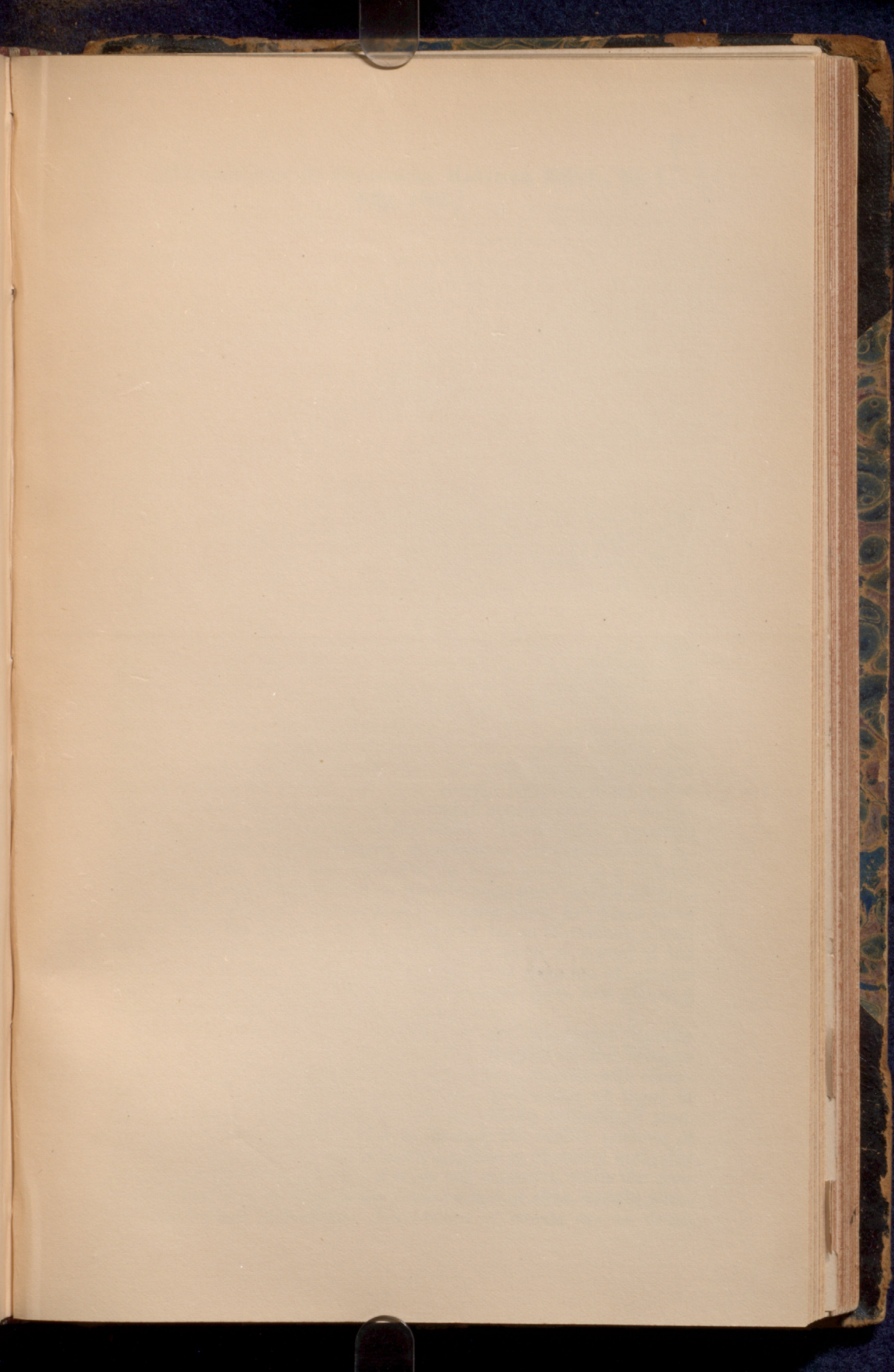
The next structure in the stem is a layer of larger and thicker walled parenchyma (Figs. 1*d* and 2*d*), which, by a gradual lengthening of the cells, and a decrease in their diameter, becomes changed into the regularly arranged prosenchyma of the circumference (Figs. 1*e* and 2*e*). These outer cells agree in every respect with true wood cells, being greatly elongated and having pointed extremities, and the method in which they are arranged is very much that of the wood cells in exogenous stems. No indication of any horizontal cellular structure has been detected in this prosenchymatous cylinder corresponding to what has been described in the scalariform tissue. The vascular bundles, accompanied with a certain amount of cellular tissue, pass upwards and outwards through it to the leaves.

In the specimen figured, the outer portion of the prosenchyma (Fig. 1*f*), consisting of six cells in depth, has a slightly different aspect from the rest, and has been easily detached from it. In position, appearance, and the ease with which it separates from the older structure, it answers to the younger growing portion of the wood in exogenous stems, and may have had a corresponding significance.

Outside this there is a layer of small thick-walled parenchyma (Fig. 1*g*), from eight to twelve cells thick, forming the external bark.

The vascular bundles can be traced through all these layers into the leaf. As they approach the surface of the stem they have a somewhat circular transverse section. A small quantity of cellular tissue occupies the centre of the bundle. It is its termination in the centre of the characteristic scar of this species which gives the circular depression shown in the figures of the fossil.

The bases of the leaves are persistent, and are composed of roundish parenchyma (Fig. 1*h*). The leaves themselves seem to have been deciduous, for in a specimen where the section passes through the end of the vascular bundle, the surface of the rhomboidal elevation which supported its leaf is cicatrized, being composed of a layer of small thickened cells.



ACADIAN GEOLOGY.—THE GEOLOGICAL STRUCTURE, ORGANIC REMAINS, AND MINERAL RESOURCES OF NOVA SCOTIA, NEW BRUNSWICK, AND PRINCE EDWARD ISLAND. By JOHN WILLIAM DAWSON, M.A., LL.D., F.R.S., etc., etc. Second edition. London: Macmillan and Co. 1868. 8vo. pp. 694.

THIRTEEN years have passed since the first edition of this work was published. During that interval its distinguished author has been diligently and successfully prosecuting his investigations in Acadian geology. He has issued numerous memoirs, in British and American journals, on the physical structure of the region which he has made so completely his own, and on the organic remains discovered there—memoirs which have not only elucidated the geological history of Acadia, but have largely contributed to a just appreciation of the physical and biological conditions of the palæozoic epoch in other regions of the earth. These various memoirs, along with observations hitherto unpublished, are digested and incorporated with what was published in 1855, producing a volume very imperfectly characterized on its title-page as a “second edition, revised and enlarged,” inasmuch as it contains about five times more matter than the original work. It would be, as is evident, a vain undertaking to endeavour to present to the reader an account of the additions contained in this edition; we shall examine at greater length the important exposition of the Palæozoic flora, first glancing only at one or two other points of importance.

The earlier chapters on the Boulder-clay and subsequent deposits have a special interest at present. The chapter on the Micmac Indians, and the results produced by forest fires, abound with observations which must receive the careful consideration of those in Europe who are investigating the question of the antiquity of man. We have a long historic period in Europe, the earlier portions of which, in those districts where investigations as to man's antiquity have been carried on, are very obscure and mythical, while the prehistoric period is, as regards the measurement of time, utterly without any certain indications. Successions of events can be deter-

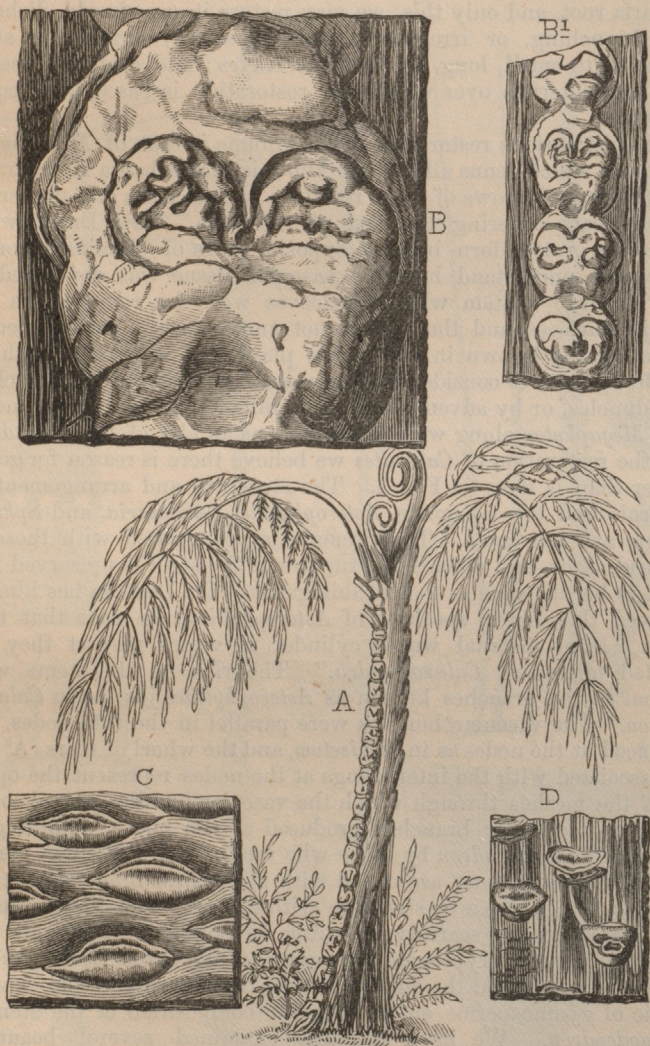
mined satisfactorily, but estimates of the time required for their occurrence are of necessity purely hypothetical. Any help to the discovery of a trustworthy time-measurer would be of great service. In the history of the Micmacs and in the succession of forests, in the same localities, resulting from natural causes, and within a known time, Principal Dawson believes that he has data for maintaining that a much shorter period was required for the ethnological and phytological changes in Denmark and other places than is generally demanded by antiquarians.

The Glacial phenomena, with the associated drift, are ascribed to the action of the sea and its currents bearing ice at certain seasons of the year, accompanied with a gradual subsidence and re-elevation of the land, while the action of Glaciers was very subsidiary. Considerable confusion has arisen from generalizing on the origin of Boulder-clays from observations made in circumscribed localities. The Boulder-clays of the South of England differ, as is well-known, from those of Scotland. They contain boulders from distant localities, associated with some obtained from neighbouring rocks, while in Scotland the deposits are local, all the boulders being derived from higher portions of the water-system in which they occur, and the clay itself deriving its colour from the predominant rocks of the district where it occurs, and from which it was derived. The local glacier will alone account for the Scottish Boulder-clay, while the phenomena of the English deposit requires the floating iceberg. It is quite evident that the Acadian Boulder-clays agree more with those of the South of England; but while arguing for their oceanic origin, Dr. Dawson must admit the local glacier origin of other deposits.

We must pass over the tempting record of the discovery of the land animals of the Devonian and Carboniferous periods, and the interesting account given of this singular fauna, which have been unearthed first and chiefly in Acadia, and by the labours of Principal Dawson; but we must especially notice the important observations he has made on the Flora of these periods. The learned author has devoted his special attention to the investigation of this vegetation which has left so large a record in the earth's crust. He has greatly added to the number of known species, he has examined into the conditions of the accumulation of coal, and determined the various microscopic structures which are met with in the coal itself. And now he proceeds a stage further, and re-uniting the broken and scattered fragments of the plants, he builds up in a series of restorations what appears to him to have been the aspect of the living plant. In the animal kingdom the work of restoration depends more on observation than on imagination, as the different parts of an organism bear a tolerably definite proportion and relation to each other; but in the vegetable kingdom, on the other hand, imagination must be the chief source of restoration where the preserved materials are few and imperfect, as no relationship exists between the size of the fruit, the flower, or the leaf, and the branch, the trunk, or the root. A careful comparison of the various organisms

and structures preserved together may check the imagination, and cautious inductions on their affinities may come very near to a de-

FIG. 1.



- A. *Megaphyton magnificum*, Dawson, restored.¹
 B. Leaf-scar of the same, two-thirds nat. size.
 B.1 Row of Leaf-scars, reduced.
 C. *Palaeopteris Harttii*, Dawson, scars half nat. size.
 D. *Palaeopteris Acadica*, Dawson, scars half nat. size.

¹ We are indebted to the publishers of the "Acadian Geology" for the use of this and the three other woodcuts from that work.

monstration of their relations; but the only method of determining with certainty the different parts of a vegetable organism is the discovery of these parts in organic connection. Thus in *Sigillaria*, as long as we know that it had a long fluted and scarred trunk and stigmata root, and only this, we may restore it as a simple, dichotomous branching, or irregularly and repeatedly branching stem covered with small, long, or fern-like leaves; and each of these, as far as the materials over which our restoration is based, with equal accuracy.

The most curious restoration in the volume is that of *Megaphyton*, (Fig. 1) of which genus all that we know is that it had a large trunk with two opposite rows of large reniform or oval scars and numerous smaller scars covering the rest of the stem. This Dr. Dawson restores as a tree-fern bearing opposite pairs of enormous fronds. We cannot understand how the vascular tissue was developed to form so large a stem when the leaves were far removed on the opposite surfaces, and their bases not amplexicaul. So opposed is this to what is known in any recent plant that we prefer, with M. Ad. Brongniart, to consider the large scars as produced by branches, by peduncles, or by adventitious roots, rather than by leaves, and to place *Megaphyton* along with *Ulodendron* as an ally of *Lepidodendron*.

In the restoration of *Calamites* we believe there is reason for going further than is done in Fig. 2. The structure and arrangement of the fruit and the foliage in *Asterophyllites*, *Annularia*, and *Sphenophyllum* are the same. Their remains are associated with those of *Calamodendron*, and when the structure of the stem is preserved it is found to be the same as that of this genus. Dr. Dawson has himself observed this, for in speaking of *Asterophyllites*, he says that they had a "stout internal woody cylinder, in which respect they resembled miniature *Calamodendra*." The ribs on the stems were internal in the branches known as *Asterophyllites* just as in *Calamodendron*. The vascular bundles were parallel in the internodes, but interlaced at the nodes as in *Equisetum*, and the whorl of scars (A^2 and A^4) associated with the interlacings at the nodes represent the opening of the meshes through which the vascular bundles passed to the whorl of leaves or branches produced at the nodes. Nothing is known of *Calamodendron* by those who retain it as a distinct genus, but that it was a stem; associated with it are these branches, leaves, and fruit, which agree in structure with it—and that they actually belonged to it can scarcely we think be doubted. The fruit was certainly that of a cryptogam belonging to the Order *Equisetaceæ*—but to this is opposed the statement that disc-bearing tissue characteristic of gymnosperms enters into the composition of the stem of *Calamodendron*. We have carefully examined several beautiful stems belonging to Mr. Binney, and a large series of our own from the Ash-bed in Arran, but have failed to detect any disc-bearing tissue. The whole vascular portion of the stem is made up of scalariform tissue, as in the larger number of vascular cryptogams, but differing in this respect remarkably from the recent *Equisetaceæ*. It would greatly add to the value of Dr. Dawson's restorations and

of one's estimate of the systematic position of the plants he is dealing with if it were obvious how far the structure he ascribes to them had been found by him in sliced sections of prepared specimens of the

FIG. 2.



A. *Calamites Suckovii*, Brongn., restored.

A¹. Foliage.

A². Ribs and scars.

A³. Roots.

A⁴. Base of stem.

B. *Calamites Cistii*, Brongn., restored.

B¹. Leaves.

B². Leaf enlarged.

C. Leaves of *C. nodosus*, Schloth.

C¹. Whorl enlarged.

D. Structure of stem.

E. Vessels magnified.

stems themselves, which could without doubt be referred by their external characters to a particular genus.

The beautiful specimens of *Calamites nodosus*, Schloth., figured by Lindley and Hutton, belonged to a repeatedly branching plant, and were not simple plants as represented at C, Fig. 2; an examination of the original specimens now deposited in the Newcastle Museum shows that the form to which they gave this name are really the branched fruiting spikes, and not the true foliage of *Calamites*.

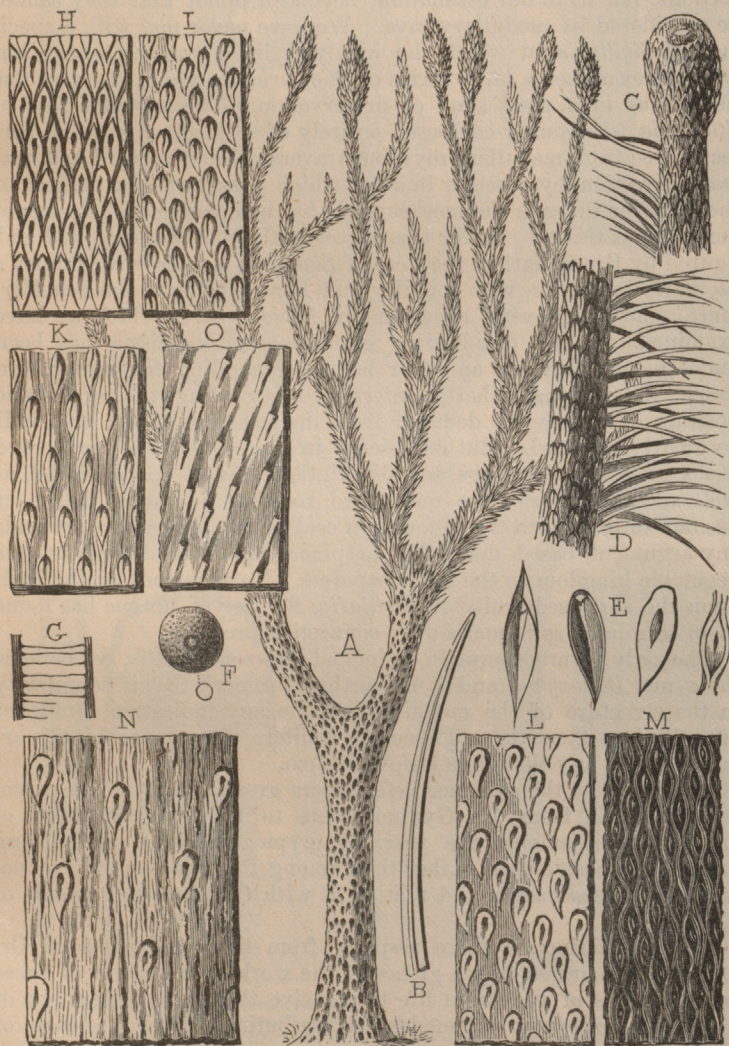
Our own observations in regard to the structure of these plants differ so much from those of Dr. Dawson that we are compelled to modify somewhat the systematic position he gives to *Sigillaria* as well as to *Calamodendron*. It is remarkable that so little is known of a genus of plants which are so abundant in Carboniferous strata, and the more so that every particular is known regarding the structure of its associated genus *Lepidodendron*. Dr. Dawson has ample authority for his restoration of his *L. corrugatum* (Fig. 3) as far as it goes. The sporangium may have been of a different form, and only one connected with each scale, as in *Lepidostrobus*; but otherwise there can be no hesitation in co-relating all the other parts. The author has done good work in tracing the different forms of scars, which without persevering research would have been, by a more hasty and careless worker, referred to several distinct species. That *Lepidodendron* belongs to the vascular cryptogams, and had the habit of, if it did not belong to the Order of *Lycopodiaceæ* every one acknowledges. And that in all characters in which they can be compared—except the microscopic structure of the vascular axis of the stem—these two genera were closely allied is also generally admitted—indeed it is very difficult in many cases to determine to which of the genera some species should be referred, and no characters can be drawn which will suffice to distinguish the *Favularia* group of *Sigillaria* from the group of *Lepidodendron* to which Dr. Dawson applies the name *Lepidophloios*.

The characters derived from the internal structure of the stem are those upon which the two groups are separated into genera, and by some authors placed widely apart systematically. Brongniart's admirable memoir on the structure of *Sigillaria elegans* is still the most complete exposition of the subject. He describes it as consisting of a cellular axis surrounded by a double cylinder of vascular tissue, the inner consisting of distinct bundles of a lunate form and the outer regularly arranged in radiating series, sometimes broken up by narrow radiating intervals supposed to have been occupied by medullary rays. Beyond the vascular cylinder was a cellular layer, becoming more dense towards the circumference, and traversed by the vascular bundles which passed out to the leaves. This description agrees with the figure given by Dr. Dawson (Fig. 4, C), except that Brongniart saw no indication of diaphragms (*a*) in the cellular axis, or of a cylinder of disc-bearing tissue (*b*); and also with the section of (*Lepidodendron*) *Lepidophloios Acadianus* (*Acadian Geology*, p. 457, fig. 1).

Dr. Hooker, in his *Essay on the Carboniferous Flora*, doubts

whether the appearance in the fossil which Brongniart considers as representing medullary rays are really so or not. The relation of

FIG. 3.



- A. *Lepidodendron corrugatum*, Dawson, restored.
 B. Leaf, nat. size.
 C. Cone and branch.
 D. Branch and leaves.
 E. Various forms of leaf areoles.
 F. Sporangium.
 G. Scalariform vessel, magnified.
 H. I, K, L, M. Bark with leaf-scars.
 N. Ditto of old stem.
 O. Decorticated stem (*Knorria*).

these so-called medullary rays to the vascular axis and to the separate internal vascular bundles, together with the entire absence of any indication of the cellular structure of the medullary ray in radial sections, put it, in our estimation, beyond a doubt that they cannot be considered as medullary rays. We have never met with a specimen of *Sigillaria* in which the woody cylinder was preserved, but we have examined a large series of *Stigmaria* in which the vascular tissue was in a good state of preservation. The vascular axis of *Stigmaria* is certainly composed entirely of scalariform vessels, perfectly free from medullary rays, but traversed in an upward and outward direction by vascular bundles which pass from the interior of the cylinder through the meshes made by the opening and closing of the vascular tissue.¹ So far this agrees with what was observed and figured by Brongniart in the stem of *Sigillaria elegans*, with Binney's *Sigillaria vascularis*, with Lindley and Hutton's *Lepidodendron Harcourtii*, and with several specimens of *Lepidodendron* which we have examined. If true disc-bearing gymnospermous tissue has been found *in situ* forming an outer layer surrounding the scalariform tissue, the notions hitherto entertained regarding the systematic position of this genus deduced from the structure of the stem will be greatly modified. But its absence in those exquisitely preserved stems of which drawings and descriptions have been published, as well as in *Stigmaria*, the undoubted roots of *Sigillaria*, makes us hesitate to refer such tissue found in coal to this genus, and set aside any argument based upon this to place *Sigillaria* as high in the vegetable kingdom as the Gymnosperms. No argument can be built upon the supposed fruits of *Sigillaria*, for, as yet, no one has found them so related as to make their connection probable.

The only Gymnosperm in Principal Dawson's list is, we believe, the genus *Dadoxylon*, and it is worthy of remark that if complexity in the structure of the medullary ray be any indication of higher organisation, then these Palæozoic conifers were more highly organised than any that have followed them.

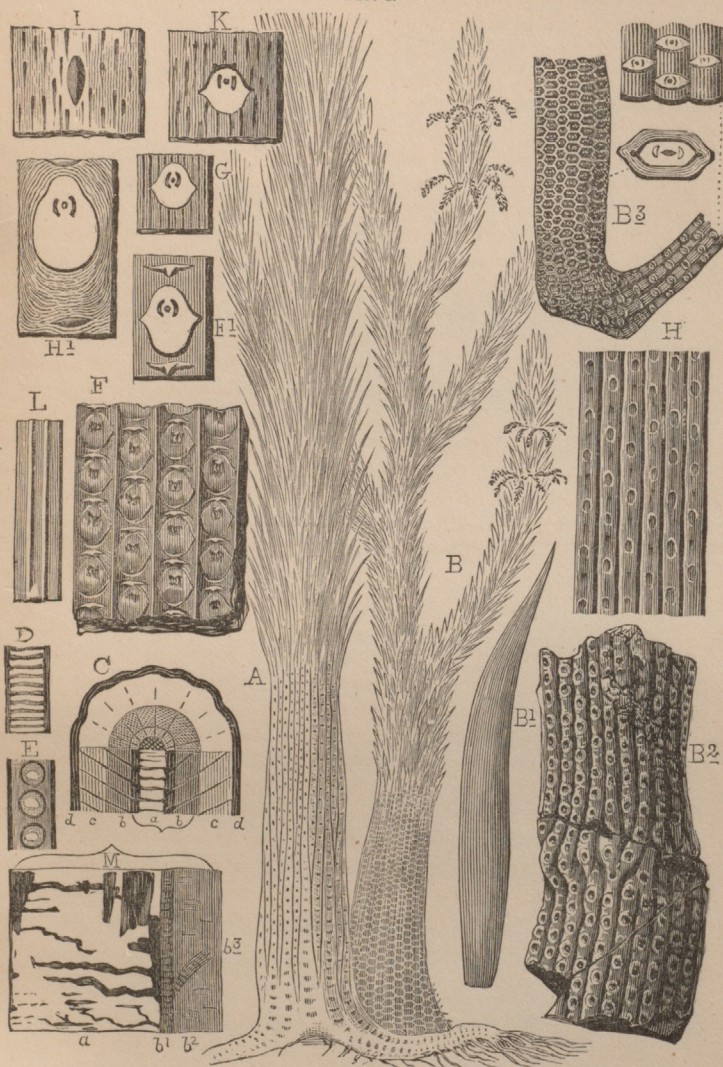
To conclude, the evidence before us is greatly in favour of reducing *Sigillaria* from the Gymnosperms to the neighbourhood of *Lepidodendron* among the vascular cryptogams, and of placing *Megaphyton* beside them rather than among the ferns, and of reducing also *Calamodendron* and uniting it with *Calamites* as a genus of *Equisetaceæ*.

While differing in these respects from the conclusions of Dr. Dawson, it requires only a glance at the work by a student of these ancient forms of vegetable life to perceive that there is here one of the most important of modern contributions to the science of palæontological botany.

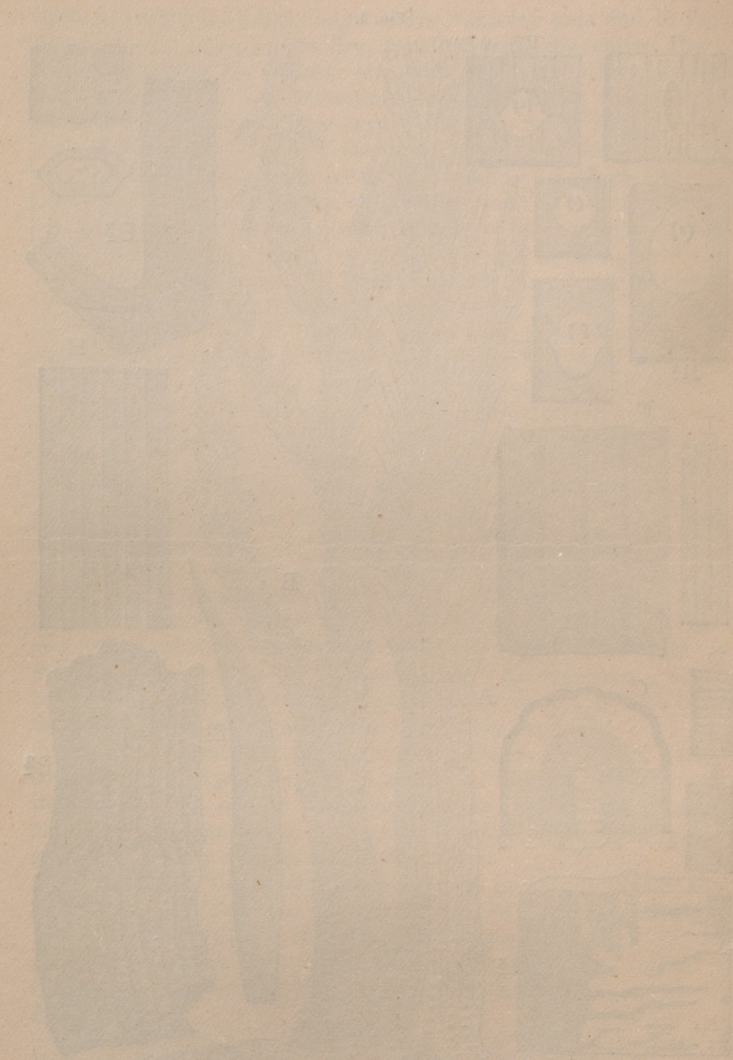
W. CARRUTHERS.

¹ We write this remembering that Cotta has figured a longitudinal section of *Stigmaria ficoides*, the vascular tissue of which is composed of Cycadean-like vessels traversed by the muriform cells of medullary rays, but it is quite certain that if this is a faithful representation of the wood of the fossil, the fossil is not *Stigmaria ficoides*.

FIG. 4.



- A. *Sigillaria Brownii*, Dawson, restored.
 B. *S. elegans*, Brongn. restored. B¹. Leaf of *S. elegans*. B². Portion of decorticated stem, showing one of the transverse bands of fruit-scars. B³. Portion of stem and branch reduced, and scars nat. size.
 C. Cross section of *Sigillaria Brownii* (?), reduced, and portion at (M) nat. size.—(a). Sternbergia pith.—(b¹). Inner cylinder of scalariform vessels.—(b²). Outer cylinder of discigerous vessels, with medullary rays and bundles of scalariform vessels going to the leaves at (b³).—(c). Inner bark.—(d). Outer bark.
 D. Scalariform vessel, magnified. E. Discigerous woody fibre, magnified.
 F. *S. Bretonensis*, Dawson. (F¹). Areole, half nat. size.
 G. *S. striata*, Dawson, nat. size.
 H. *S. eminens*, Dawson, reduced. (H¹). Areole, half nat. size.
 I. *S. catenoides*, Dawson, half nat. size. K. *S. planicosta*, Dawson, half. nat. size.
 L. Portion of leaf of *S. scutellata*, Brongn.



THE HISTORY OF THE UNITED STATES
 BY JAMES M. SMITH
 VOL. I
 PART I
 CHAPTER I
 THE FOUNDING OF THE NATION
 THE first step towards the formation of a nation was the signing of the Declaration of Independence in 1776. This document declared the thirteen colonies to be free and independent states, no longer subject to British rule. The signing took place in the city of Philadelphia, where the Continental Congress was then meeting. The document was signed by John Hancock, who placed his signature in large, bold letters at the top of the page. Other prominent signers included John Adams, Benjamin Franklin, and Thomas Jefferson. The Declaration of Independence was a landmark event in American history, as it marked the birth of the United States as a sovereign nation.

22

THE
JOURNAL OF BOTANY,
BRITISH AND FOREIGN.

NOTICE OF A FOSSIL LYCOPODIACEOUS FRUIT.

BY M. BRONGNIART.

(Translated from the '*Comptes Rendus des Séances de l'Académie des Sciences*,' vol. lxvii. ; *Séance Août 17, 1868.*)

The study of the vegetable fossils of the palæozoic rocks presents a peculiar interest on account of their singular forms, which generally separate them in a very remarkable manner from the plants now living on the earth.

With the exception of the Ferns, which have a similar form throughout all time, the other plants of the coal period differ so greatly from those of the later periods, as well as those now living, that the most careful examination has failed to refer them to families of recent plants.

However, since I began my researches, I have determined the affinities of several arborescent plants of this period to *Equisetaceæ* and *Lycopodiaceæ*.

* Compare Guibourt, '*Drogues Simples*,' 1850, t. iii. pp. 135, 136.

In respect of the latter family, I united to the large stems and branches which form the genus *Lepidodendron* certain spikes, or cones of fructification, which appeared to me to be the cones of these gigantic *Lycopodiaceæ*, and which I designated by the name *Lepidostrobus*.

Since then, these relations have been completely confirmed by the observations of Dr. Joseph Hooker on several specimens of *Lepidostrobus*,* enclosed in nodules of carbonate of iron, from the English coal-field, the internal structure of which had been so well preserved as to exhibit, much better than I had seen, the form of the sporangia borne on the scales of these cones, and the nature of the spores contained in them.

Another specimen, remarkably well preserved, the origin of which was unknown, had been previously described by our illustrious associate R. Brown, under the name of *Triplosporites*. His profound study of this specimen in 1847, and the additional observations made in his memoir in 1851,† after the examination of a beautiful specimen which I showed him in 1849, convinced him of its intimate relations to *Lepidostrobus*, from which he hesitated to consider it as generically distinct.

But the specimen described by Robert Brown,‡ as well as that of the Museum at Strasbourg, half of which had been given to the Museum at Paris, and which I showed him, presents only short portions of those cones; that described by Robert Brown belongs evidently to the summit of a cone; that which I had studied appeared to proceed from its base, but the perfect specimen which is the subject of this notice shows that it rather belonged to the middle portion of one of these spikes of fructification. Indeed, the lower portion of these cones presents very remarkable differences of organization, which must materially modify the characters ascribed to these fossils, and appear to indicate greater differences between them and *Lepidostrobus* than one would have supposed, if the organization of these latter fruits has been fully understood from the specimens described by Dr. Joseph Hooker.

* 'Memoirs of the Geological Survey of Great Britain,' vol. ii. p. 440.

† "Some Account of *Triplosporites*, an Undescribed Fossil Fruit." Transactions of the Linnean Society, vol. xx. p. 469, 1851. (Read to the Society June 15th, 1847.)

‡ This specimen was obtained from the collection of Baron Roger, and a transverse section preserved in the collection of the Marquis de Dré now forms part of the collection of the Museum of the Jardin des Plantes.

The numerous spikes of fructification—many of them, however, very imperfectly preserved—examined by this excellent observer are often very small portions of the cones; some of them, however, seem to have been preserved in full, and there is no indication of difference of structure between the base and summit. All the scales bear sporangia of the same form, which appear to enclose bodies of the same nature; this is, at least, what the figures and descriptions published by the learned English botanist indicate.

These characters seem, then, to place *Lepidostrobus* among true *Lycopodia*, the sporangia of which are all alike, and enclose similar spores.

The family of *Lycopodiaceæ* contains two other genera very different in this respect, *Selaginella* and *Isoëtes*, which, on the same stem or in the same spike,—that is to say, on the same axis,—have two kinds of sporangia, the one containing very small spores destined to produce antherozoids, and to become fecundating organs; the other much larger spores, which germinate after being fecundated. These two organs have been designated by the names of *microspores* and *macrospores*.

There is nothing in the specimens described by R. Brown, or by Dr. J. Hooker, which indicates this double nature of the sporangia and spores; but a very perfect and on the whole well-preserved specimen of a spike, identical in its upper part with the *Triplosporites* of R. Brown, throws a new light on this subject, and shows a modification in these points analogous to what we observe in living *Lycopodiaceæ*.

This remarkable specimen was found in the drift at the entrance of the valley of Volpe, in Haute-Garonne, by M. Dabadie, apothecary; it was given to me by M. Lartet, to whom M. Dabadie had entrusted it, and the discoverer of this interesting specimen has been good enough to allow me to make a longitudinal section of it, and to keep the half of it for the Museum.

This specimen, of which a cast was carefully taken before being cut, is completely silicified; the organization of the different parts is well preserved in many points; but the anfractuosités and the crystallized parts do not allow an equally complete examination throughout.

It is a cone or cylindrical strobilus, 4 inches $8\frac{1}{2}$ lines long, and 2 inches $1\frac{3}{4}$ lines broad, showing on the exterior the summits of the scales of which it is composed; these form twenty-seven perfectly

regular longitudinal rauges, which are disposed in a very elliptical helix, whose generating spire would be expressed by the fraction $\frac{2}{37}$,—an arrangement approaching that seen in several living *Lycopodiaceæ*.*

The scales or bracts which form the spike are borne perpendicularly on the axis, and are even a little reflected; as they have exactly the structure so well described by R. Brown in his *Triplosporites*, it is unnecessary for me to repeat it. As in his specimen, they take an erect direction towards their apex, and terminate at the surface of the fossil in a hexagonal disk, which should, as in *Lepidostrobus*, be prolonged into a foliaceous appendix, but this has been destroyed.

On the narrow pedicels of these scales are inserted oblong sporangia, rounded at their extremities, as in *Triplosporites*; those which occupy the summit and middle portion of the spike are filled with an innumerable quantity of little spores, formed of three or sometimes of four spherical united cellules, which in some cases appear to separate into simple globular spores.

On the lower portion of the spike we find sporangia similar in form and in their mode of attachment to the preceding, but which are obviously distinguished from them by the spores which they contain being simple, spherical, and of a considerable size, their diameter being ten or twelve times greater than that of the smaller spores. They are very distinct to the naked eye, their diameter being three-tenths of a line, and enable one at once to detect the sporangia containing the microspores.

These larger and perfectly spherical spores have a thick, smooth covering; they generally contain scattered globular granules, the nature of which it is difficult to ascertain, but which seem to indicate an immature state; some, filled with an opaque matter, appear more advanced in their development.

This spike thus presents, as in the Lycopodiaceous genera *Selaginella* and *Isoetes*, sporangia of two kinds, the one towards the summit containing microspores,—that is to say, antheridia; the others, placed towards the base of the spike, containing macrospores, or germinating spores.

The form and mode of attachment of these sporangia, their large size, the great number of microspores they contain, the absence of any

* I have represented this arrangement of the leaves of *Lycopodiaceæ* in the 'Histoire des Végétaux Fossiles,' vol. ii. plate ii.

trace of a line of regular dehiscence, are points in which they resemble specially the sporangia of *Isoëtes*; but in this genus the sporangia are situated at the very base of the leaves, which are borne on a very short and bulbiform stem.

In the fossils, on the contrary, the sporangia are borne on a kind of bracts, or squamæform leaves united in a spike, which, like those of *Selaginella*, probably terminated the branches.

There is, then, here a singular combination of characters: sporangia analogous to those of *Isoëtes*, arranged in a spike similar to that of *Lycopodium*, but much larger.

The great size of their organs is, indeed, one of the striking characteristics of these spikes. It agrees with the arborescent habit of *Lepidodendron*, compared with that of the living *Lycopodiaceæ*, but it is not on this account the less remarkable, as the organs of reproduction do not generally follow the growth of the vegetative organs; the largest tree-ferns have not greater sporangia than the smallest species; and, in the same way, the flowers of our large trees are often smaller than those of the most humble herbaceous plants.

In these palæozoic plants the growth has been simultaneous in the two systems of organs.

Thus, *Lepidodendron*, a genus of arborescent *Lycopodiaceæ*, had spikes of fructification agreeing in their size with the cones of Firs and Cedars, containing very large sporangia, rather than with those of *Isoëtes*, which they resemble in form and structure.

And the question remains to be considered, have the fruits of true *Lepidodendron*, i. e. *Lepidostrobus*, which have been described by Dr. J. D. Hooker, only one kind of spores, or has the imperfect state of the specimens prevented the true nature of the spores contained in the lower sporangia of the spike from being ascertained? The form of the spores of *Lepidostrobus* differs so much from those of the microspores of *Triplosporites* as to induce me to consider these plants as belonging to different genera, and that the genus *Triplosporites* of Robert Brown ought to be retained.

The three known specimens of this fossil do not enable us to establish its true geological position. The origin of that described by R. Brown and of the one in the Strasbourg Museum is entirely unknown. That which I have just described was found in the drift in a Pyrenean valley far from the formation in which it was originally preserved;

there can be no doubt, considering the group of plants to which they are related, that they have been obtained from deposits contemporary with the Coal or Red Sandstone formations.

Robert Brown, in his memoir, has not given any specific name to the plant he has described; but the establishment of its generic value, and the probability that other forms of the same genus will be found, induce me to perpetuate the memory of his important observations by naming this species *Triplosporites Brownii*.

I ought, in conclusion, to remark, that this very perfect specimen which I have described probably represents a spike not fully developed. Two things seem to indicate this: *first*, the microspores are, in almost all the sporangia that contain them, immersed in an opaque granular substance in which they show themselves by their transparency, and which appears like the cellular plasma that surrounds these organs before maturity; *second*, the vessels which form the very distinct bundles in the axis of the cone, show only transverse striæ or very indistinct rings, and not the decided lines of adult scalaridiform vessels.

This immature condition has, perhaps, favoured the beautiful preservation of these fossils; but it is possible, and even probable, that the microspores and macrospores, when completely developed, would present some differences, which need not be considered as proceeding from a really distinct organization. Some of the spores forming the triple microspore seem already disposed to isolate themselves, and might, perhaps, take the trigonal form indicated by Dr. Hooker in the spores of *Lepidostrobus*. Some of the macrospores seem also to present in the interior a more complicated structure, which may indicate a tendency towards the appearance on the trigonal summit of the macrospores of *Isœtes*.

New specimens, even simple fragments, but in a different stage of development, may turn up to complete our knowledge; but now the existence of gigantic *Lycopodiaceæ*, more completely correlated with living forms of the Order, is indubitably established.

THE BRAZILIAN COAL FIELDS.

By NATHANIEL PLANT, F.R.G.S., F.G.S., etc.

With a Description of the Plant-Remains, etc., by W. CARRUTHERS, F.L.S., F.G.S.,
of the British Museum.

THE presence of Coal-beds in South America has been known for several years, but the only localities on this side between the Amazon and the River Plate where their existence has been actually determined, are in the two extreme southern provinces of Brazil, Rio Grande do Sul, and in the adjoining one of Santa Catherina, and in the neighbouring Republic of Banda Oriental or Uruguay.

Lignite, brown-coal, and bituminous schists occur in thin beds along the coast and in the interior of Maranhão and Minas Geraes; but it is only in these three southern provinces that true Carboniferous rocks containing palæozoic fossils have hitherto been discovered; nor should I think it likely, from the observations I have made in nearly every province in the Brazilian Empire and the Republics of the River Plate, that true Carboniferous rocks will ever be found north of the province of Santa Catherina, unless it be in the adjoining one of Paraná (lat. 25° S.)

The province of Rio Grande do Sul contains three distinct Coal-basins, all of which I have examined, and ascertained, in some degree, the extent and thickness of the Coal-strata. They are all contained within the limits of lat. 30° and 32° S., long. 51° and 54° N., and are separated from each other by rolling hills of granite, syenite, mica-schist, and trachytic and basaltic rocks. The largest of these deposits is, perhaps, the one occupying the valleys of the rivers Jaguarão and Candiota between lat. 31° and 32° , long. 53° and 54° . The sedimentary rocks forming this basin have an uniform inclination of 10° to 15° towards the south, and apparently rest upon the mica-schist and sienitic rocks which enclose the valley of the river Jaguarão and its confluent. The falling away of one side of a hill in this basin, near its basset-edge, on the banks of the Candiota, laid

bare the strata to a considerable depth, disclosing five distinct beds of bituminous coal ranging in thickness from 9 feet to 25 feet, giving 65 feet as the total thickness of the coal exposed. The accompanying Section will show the order of superposition and thickness of the different beds as they appear on the face of the escarpment.

The *Sandstone* (No. 1) is evidently the uppermost rock, and forms two ranges of hills, one dividing the waters of the Jaguarão from those of the Candiota, and the other separating the tributaries of the Candiota from those of the Jaguarão-chico. The thickness of this bed varies considerably, being in some parts completely worn away, and in others attaining a depth of upwards of 200 feet. It contains nodules of argillaceous peroxide of iron. Immediately below this sandstone is found the first seam of coal-shale, 9 feet thick, which can be traced wherever the superincumbent sandstone has been denuded, for about 50 miles along a line running N.E.-S.W., and for about 30 from N.W.-S.E. Below this is a bed of sandy-shale, three feet in thickness, containing ochreous oxide of iron in the form of septaria; this overlies a bed of semi-bituminous coal (No. 4) which rests upon a thin seam of whitish clay, below which is another bed of coal, separated by a thin bed of blue clay (No. 7) from coal of a highly bituminous nature and possessing a thickness of 17 feet; this again is divided by a parting of clay similar to No. 7, from a bed of coal containing bands of Cannel-coal, having a thickness of 25 feet and very bituminous.

Impressions of palæozoic plants occur in this bed and in the iron-stone shale (No. 11) upon which it rests. The thickness of this iron-stone I have not been able to ascertain; but it evidently rests upon sandstone (No. 12), which is similar in every respect to the upper bed of sandstone. This is the lowest bed shown in the escarpment; but from observations which I took in another part I found that this sandstone (No. 12) rested upon beds of limestone, which in some places appear to be separated by mica-schist.

The Carboniferous rocks of this basin have apparently been but little disturbed by eruptive rocks, although basaltic dykes of considerable width are evident in the surrounding schistose and syenitic hills.

The second basin lies in the valley of the São Sepé, one of the tributaries of the river Jacuahy, in about lat. $30^{\circ} 20'$, long. $53^{\circ} 30'$. Two distinct beds of coal, one of 7 feet and the other of 14 feet thick, appear in this locality underlying the same sandstone beds, which in some places have been tilted up and overflowed by trachytic dykes. The Carboniferous deposits in this valley have been traced over an area of about 15 miles.

The third coal-basin is near the town of the São Jeronymo, on the banks of the river Jacuahy, lat. 30° , long. $51^{\circ} 30'$. The coal in this place is being worked by a Lancashire coal-viewer, Mr. James Johnson. The sections of two shafts sunk on the edge of the basin shew a superposition of rocks similar to the deposits on the Candiota. At the depth of 19 yards, a bed of highly bituminous coal 6 feet thick was met with; below this is a bed of iron-stone shale containing fossils of the same genera as those found in the beds at Candiota.

(Beitrag, p. 17).¹ In the only species described by Corda, *L. crassicaule*, the bases of the leaves are larger and proceed from the stems in a line having the same direction as that of the leaves, which are articulated to them. In these stems from Brazil, the permanent slender bases of petioles (Pl. V. Figs. 1, 7, 8), shortly after leaving the stem, take an ascending direction parallel to the surface of the stem, and pass somewhat over the base of the petiole above before the leaf is given off. In the fresh plant the imbricated petioles would give a continuous surface parallel to the circumference of the stem. Although this appearance is not exhibited in any of the specimens from Brazil, it is clearly shown in a species from Cape Breton Island, for which I am indebted to Mr. Edgecombe Chevallier. A specimen of the same species is figured by Geinitz under the all-absorbing name of *Lepidostrobus variabilis*, Lindl. (Versteinerungen, tab. ii. figs. 1, 3, 4). In these figures the stem is shown densely covered with the permanent petioles, and at B' fig. 1, the imbricated surface of the end of the petioles is shown, while at the margins of the specimen the relation of the leaves themselves to the petioles is also clearly shown. It would be rash to affirm that this structure is peculiar to the genus *Flemingites*, but future discoveries may show that it is.

In *Flemingites Pedroanus* the curve of the leaf is the reverse of that of the permanent petiole, being bent outwards and downwards. The impressions of the leaves on the shale is, in some specimens, so perfect, that even the venation can be seen; and this is parallel, as is shown in the magnified portion on Plate V., Fig. 6.

The sporangia are considerably smaller than those of *F. gracilis*, as may be seen by a comparison of figure 4, Plate V., with figures 4, 5, 6 of Plate XII. GEOL. MAG. Vol. II., 1865, these various figures being drawn to the same scale. The tri-radiate ridge on the under surface, by which the sporangia were attached to the supporting shale, is more delicate, and is produced further towards the circumference than in the British species. The contents of one of the sporangia in a compacted condition, yet with indications of their original granular state, is shown in Fig. 2. The mineral condition of the sporangia is like that of the specimens I have examined from our British deposits, and which Prof. Morris has described as "neither bituminized nor mineralized, but in a state of brown vegetable matter."

The discovery by Brongniart of a cone containing microspores in the sporangia of its upper portion, and macrospores in those of its lower portion,¹ has led me to re-examine the nature of the contents of the sporangia of these fossils, and somewhat to alter the opinions I expressed in the paper on *Flemingites*, which has been referred to.

While the size of the individual plant is very variable among species of the same natural order of Cryptogamia, that of the organs of reproduction, the spores, is remarkably uniform. The spore of

Glasgow, to whom science is indebted for the discovery of this very interesting deposit of coal plants. I may add to the synonymy of Corda's species, *Cycadium cyprinopholis*, Guillard = *Cycadites cyprinopholis*, Morris, a fossil from the Coal-measures of the centre of France, hitherto considered to be a Cycadean stem.

¹ Comptes Rendus des Séances de l'Académie des Sciences, Août 17, 1868. Translated in the Journal of Botany, Jan. 1869.

the humble Wall-rue (*Asplenium Ruta-muraria*, L.) is as large as those of the giant *Alsophilas* and *Cyatheas* of tropical regions. And this holds good also in respect of allied plants widely removed in time, as, for instance, in the spores of *Equisetum* and *Calamites* (*Volkmannia*). The spore of *Equisetum sylvaticum*, L. measures .0019 of an inch across, while that of *Volkmannia Binneyi*, Carr. measures .002 of an inch.

We find also a corresponding relationship between the spores of the palæozoic and those of the living *Lycopodiaceæ*. The microspores of *Selaginella selaginoides*, Link (*Lycopodium selaginoides*, Linn.) are .0024 of an inch across, while those of Mr. Brown's specimen of *Triplosporites* are .0022 of an inch in diameter. On the other hand the macrospores of the same *Selaginella* are .0275 of an inch in diameter, while the macrospores discovered and described by Brongniart in his specimen of *Triplosporites* are, he says, ten or twelve times the size of the microspores, that is to say, taking the measurement from Mr. Brown's specimen, from .022 to .0264 of an inch. The singular relationships indicated by these actual measurements between the spores of the *Lycopodiaceæ* are very remarkable. They moreover establish beyond question that the spores of *Lepidostrobus*, and those described by Robert Brown in his specimen of *Triplosporites*, are microspores.

The contents of the sporangia of *Flemingites* have been so altered before fossilization that the individual spores cannot be separated. In *F. gracilis* I found several specimens which presented slight prominences produced by grains in the interior. These prominences have a diameter of .0028 of an inch, which, making an allowance for increase of size produced by the interposed wall of the sporangium agrees exactly with the measurement of the microspores of *Triplosporites*. The contents of some of the sporangia of *F. Pedroanus* present also a granulated appearance, a slight remaining indication of the original individual spores, and these agree in size with the prominences on the sporangia of *F. gracilis*.

It follows, then, from these considerations, that these arborescent genera are true *Lycopodiaceæ*, completely agreeing in the structure, economy, and size of their spores with the living, though very diminutive, members of the Order; and further that, as among the living representatives, some genera (*Selaginella* and *Isoetes*) have both macrospores and microspores, and one large genus (*Lycopodium*) has, as far as known, only microspores, so, in the palæozoic forms, *Lepidostrobus* and *Flemingites* have microspores only, while in *Triplosporites* both forms exist.

Mr. Binney lately communicated to the Literary and Philosophical Society of Manchester a paper on *Lepidostrobus* and allied cones, the abstract only of which has been published. In this abstract it is said, "In the new genus *Flemingites*, described and figured by Mr. Carruthers in Vol. II. of the GEOL. MAG. for October, 1865, there are two kinds of sporangia, those in the upper part of the long and slender cone being something like the sporangia of the *Lepidodendron*, but arranged in whorls, and probably filled with microspores, whilst the lowest scales supported sporangia, containing macrospores. This the author gathered from much more perfect specimens than those which Mr. Carruthers had to work upon. Most certainly the little flattened discs which he described

as sporangia are found on scales at the base of the cone, and not in the middle or upper portions of it, as many of the author's specimens clearly proved."

Being unable to understand precisely the structure of the cones in Mr. Binney's collection from this abstract (made obviously by some one ignorant of the subject with which the author was dealing), and being engaged in working out the points treated of in this paper, I asked Mr. Binney for some additional information, but he informed me that he was about to publish a full account with illustrations, and therefore wished to reserve his more detailed description till then. As, however, the statements published in this quotation are in opposition to the views I formerly published, and have more fully explained above, it is necessary that I say a word or two on the more important points contained in it.

There can be no doubt, as there stated, that the little discs were borne on the scales of the lower half of the cone of *Flemingites*, seeing that the original specimen was the lower half of a cone; but it is also equally certain that these little discs were borne as well on the scales of the middle and upper portions, for the British Museum has recently acquired a complete specimen, in which they are to be found on all the scales from the top to the bottom. The specimen to which I have already alluded as figured by Lindley and Hutton under the name of *Lepidostrobus variabilis*, shows also this structure. Besides these I have seen two specimens from Burdie House which, though not so well preserved, are equally decisive as to this point. So that whatever is the nature of Mr. Binney's cone with *Lepidostrobus*-like sporangia on the upper half, it has nothing whatever to do with *Flemingites*.

It is also certain, if the points I have stated in this paper are of any value, that the sporangia on the lower half of the cone do not contain macrospores.

But the cone described in this abstract cannot belong to any of these palæozoic *Lycopodiaceæ*, as it would be an anomaly in the vegetable kingdom, and would contradict the ascertained laws of vegetable morphology, if a plant which had its true leaves arranged in spirals, had its modified leaves, forming the fruiting cone, arranged in whorls. The words of the abstract imply a still less possible structure, for it gives Mr. Binney the credit of believing the leaves of the lower portion of the cone to be arranged in spirals, as described and figured by me, while in the upper portion they are arranged in whorls, but this must be one of those errors which the person making the abstract has unwittingly made.

Næggerathia obovata, sp. nov. Frond sessile flat, entire, elongate-obovate, attenuated towards the base; nerves dividing dichotomously, parallel. (Plate VI. Fig. 1.)

Odontopteris Plantiana, sp. nov. Pinnules broad at the base, irregularly lobed, obtuse at the apex, basal pinnules large, much and irregularly lobed; nerves arcuately parallel, dichotomous. (Pl. V. Figs. 2 & 3.)

I have associated the name of Mr. Plant with this species, as it is to his intelligent investigation of these deposits that I am indebted for the interesting specimens I have described.

EXPLANATION OF PLATES V. AND VI.

PLATE V.

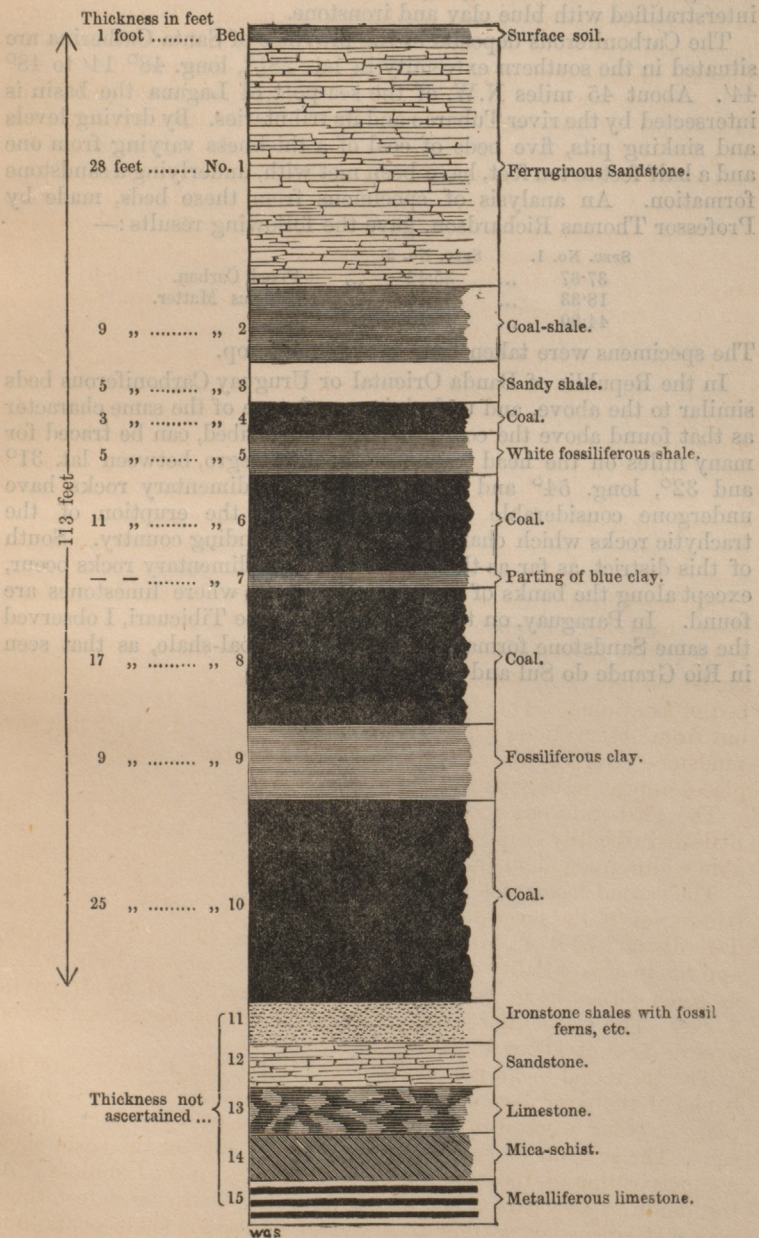
Flemingites Pedroanus.

- Fig. 1. Fragment of a stem showing the permanent bases of the petioles attached, and imbricating.
 Fig. 2. Sporangium laid open showing the granulated contents.—Greatly magnified.
 Fig. 3. Upper surface of a sporangium.—Greatly magnified.
 Fig. 4. Sporangium, magnified to the same scale as those of *F. gracilis*.—GEOL. MAG., Vol. II., Plate XII.
 Fig. 5. Sporangium with part of the upper surface removed, and showing the depression in the interior produced by the inferior tri-radial ridge.—Greatly magnified.
 Fig. 6. Fragment of leaf shewing the parallel venation.
 Fig. 7. Termination of a branch showing the solid axis, permanent bases of the petioles, and leaves.
 Fig. 8. Fragment of a branch.
 Fig. 9. " " "
 Fig. 10. " " "
 Fig. 11. A few scars from Fig. 10 magnified four times.

PLATE VI.

- Fig. 1. *Neggerathia obovata* (natural size).
 Fig. 2. Portion of a pinna of *Odontopteris Plantiana*.
 Fig. 3. Lower pinnule of the same (both natural size).

NATURAL SECTION OF BEDS SEEN IN THE ESCARPMENT AT THE "SERRA PARTIDA," RIVER CANDIOTA.



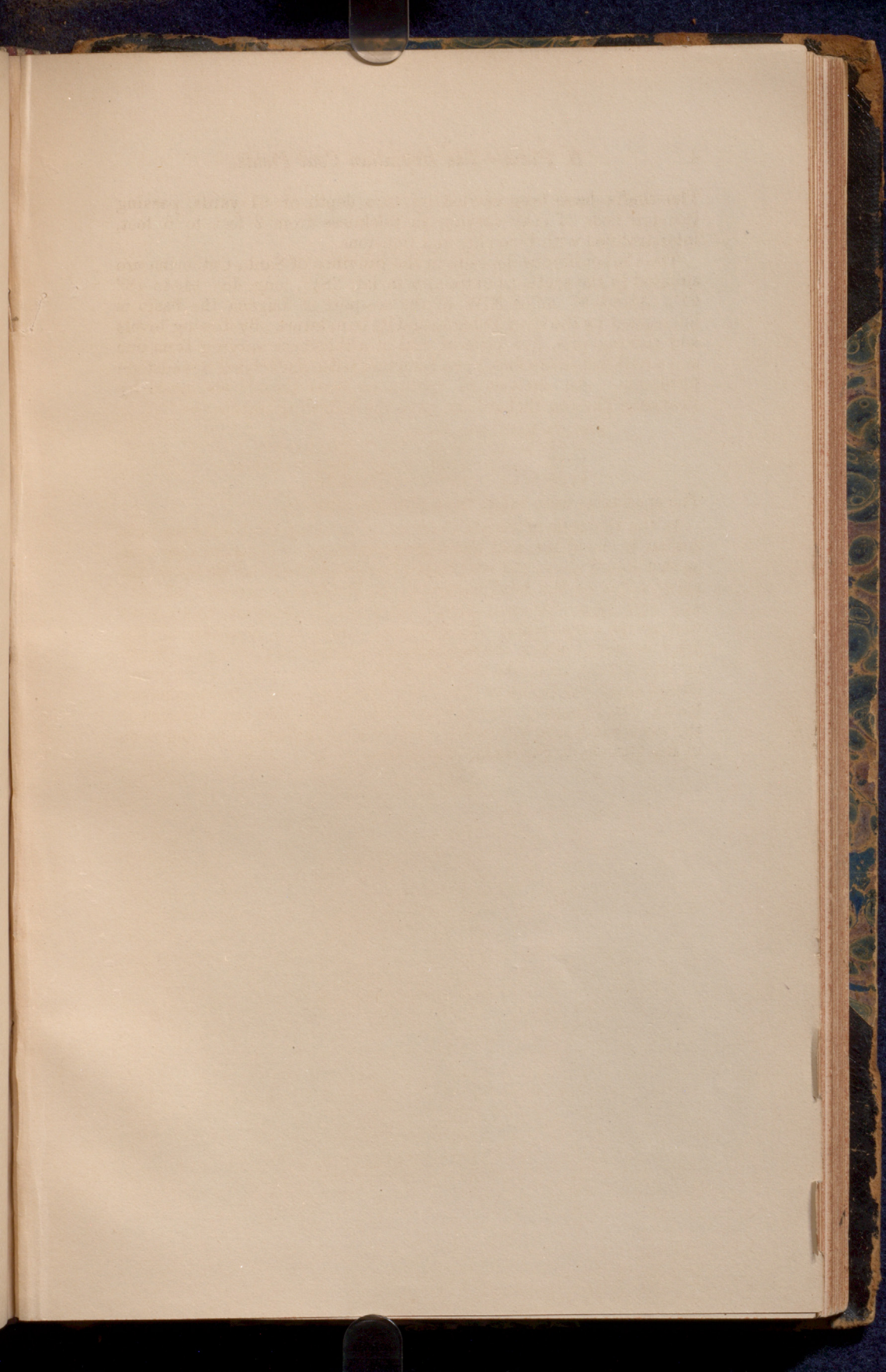
The shafts have been carried on to a depth of 61 yards, passing through beds of coal varying in thickness from 2 feet to 6 feet, interstratified with blue clay and ironstone.

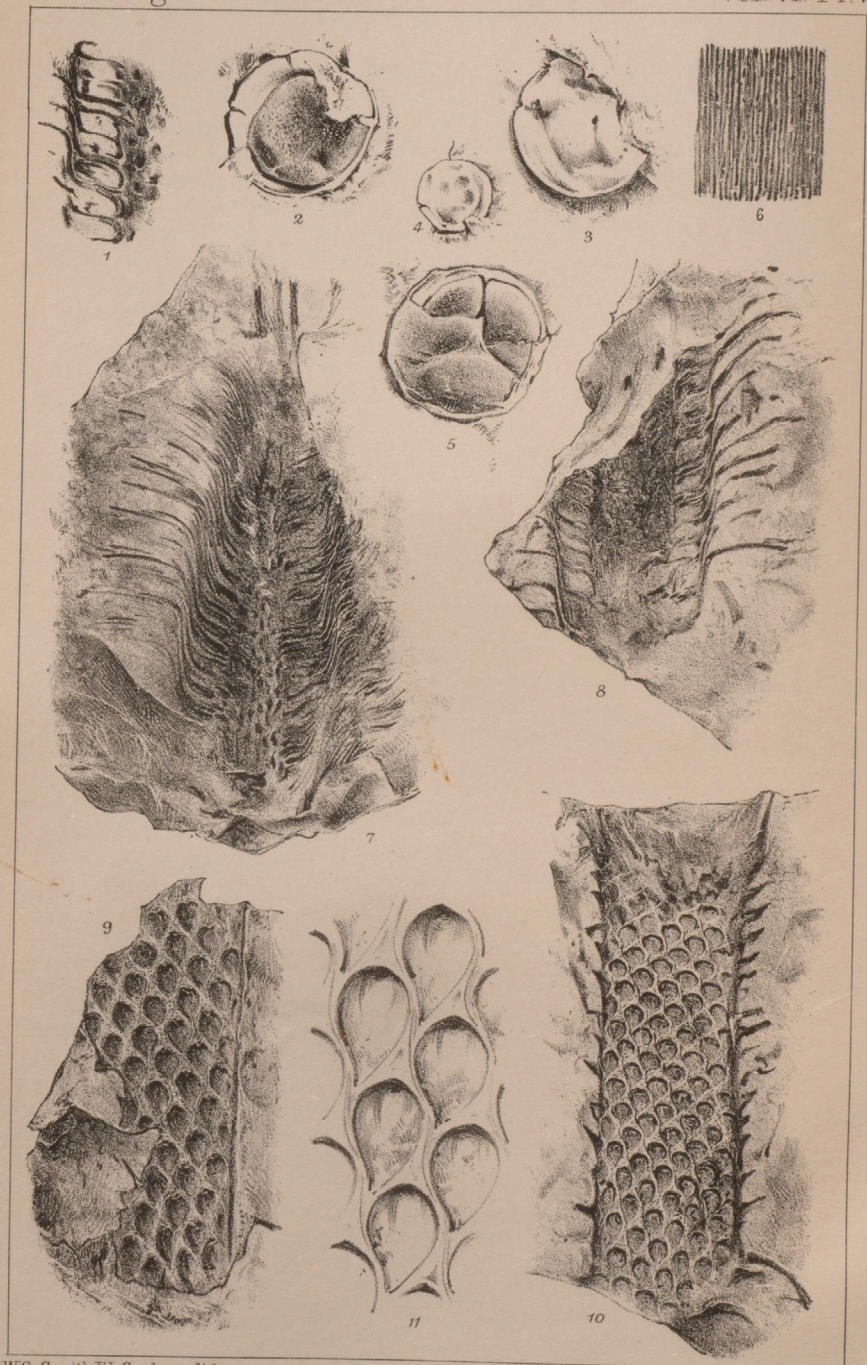
The Carboniferous deposits in the province of Santa Catherina are situated in the southern extremity in lat. $28\frac{1}{2}^{\circ}$, long. $48^{\circ} 14'$ to $48^{\circ} 44'$. About 45 miles N.W. of the sea-port of Lagana the basin is intersected by the river Tubarão and its tributaries. By driving levels and sinking pits, five beds of coal of a thickness varying from one and a half feet to ten feet, have been met with, underlying a sandstone formation. An analysis of specimens from these beds, made by Professor Thomas Richardson, gave the following results:—

SPEC. No. 1.		SPEC. No. 2.		
37.67	...	35.42	...	Fixed Carbon.
18.33	...	21.10	...	Gaseous Matter.
44.00	...	43.48	...	Ash.

The specimens were taken from near the outcrop.

In the Republic of Banda Oriental or Uruguay Carboniferous beds similar to the above, and underlying sandstone of the same character as that found above the coal-beds I have described, can be traced for many miles on the head waters of the Rio Negro, between lat. 31° and 32° , long. 54° and 55° . Here the sedimentary rocks have undergone considerable displacement from the eruption of the trachytic rocks which characterize the surrounding country. South of this district, as far as the river Plate, no sedimentary rocks occur, except along the banks of the river Uruguay, where limestones are found. In Paraguay, on the head waters of the Tibicuari, I observed the same Sandstone formation, with beds of coal-shale, as that seen in Rio Grande do Sul and S. Catherina.

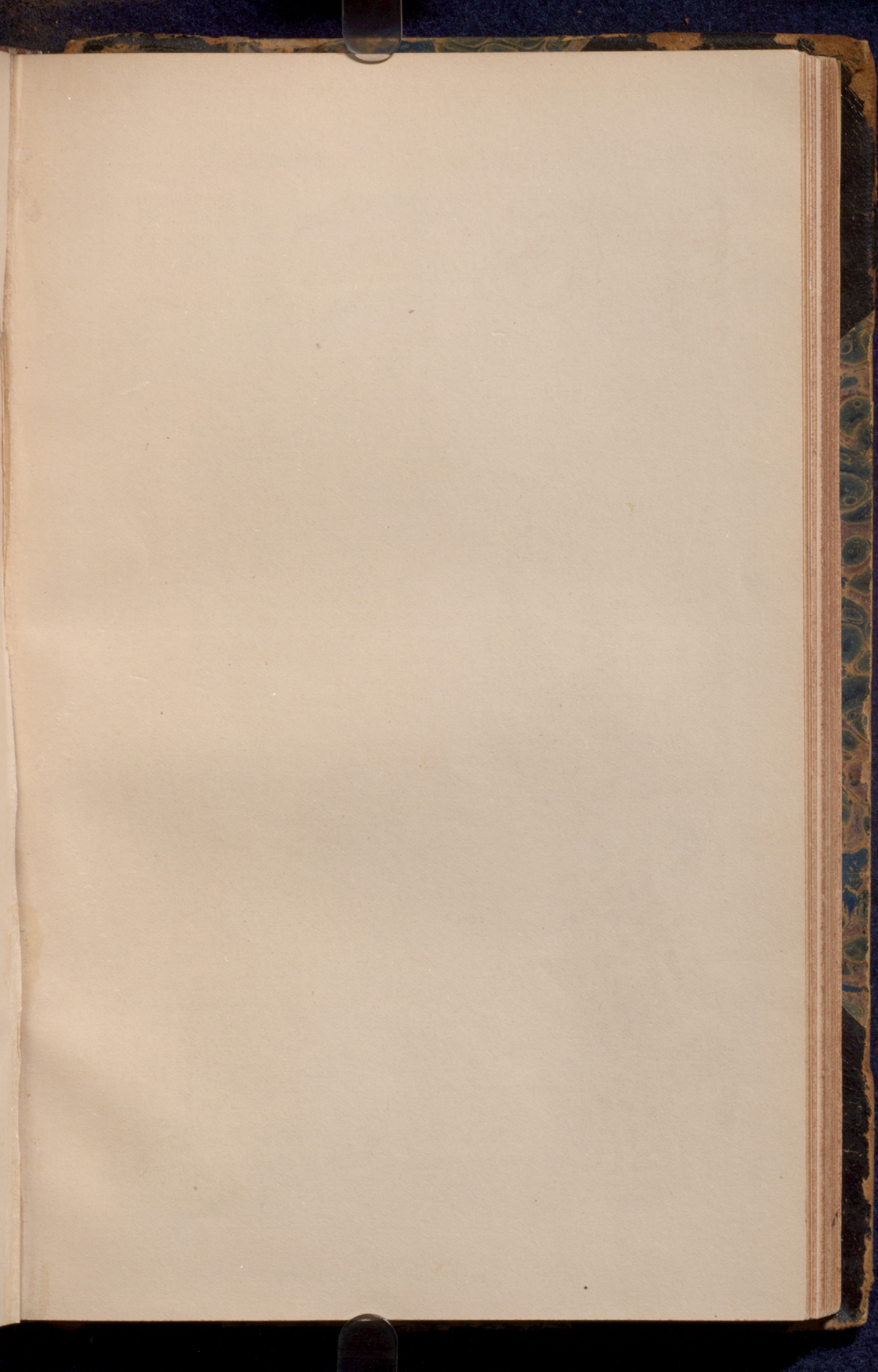




WG Smith F.L.S. ad nat. lith.

W West imp.

Flemingites Pedroanus.





W.G. Smith FLS. ad nat. lith.

W. West imp.

1. *Noeggerathia obovata*. 2. *Odontopteris Plantiana*.

ON THE PLANT REMAINS FROM THE BRAZILIAN COAL BEDS, WITH REMARKS ON THE GENUS *FLEMINGITES*.

By W. CARRUTHERS, F.L.S., F.G.S.

(PLATES V. AND VI.)

THE specimens placed in my hands by Mr. N. Plant from Rio Grande do Sul consist of a few specimens of coal and a considerable number of a highly ferruginous shale. The coal contains no recognizable fossils, but they abound in the shale. The substance of the plants is converted into a brittle coal, that possesses no structure, and exhibits the form only of the organism, but the superficial structure and the venation is often so beautifully preserved on the surface of the shale, when the coal is removed, that the nature of the fossils is very clearly exhibited. I have, thus, been able to determine with precision three species, and to recognise more vaguely a number of other forms, which, however, it would be injudicious, until additional material is obtained, to name or describe from the specimens in my possession. All these forms, as far as they can be determined, and certainly the three well-preserved species, belong to Palæozoic genera, species of which occur in the Coal-measures of Britain. We are thus enabled with certainty to refer the Coal-fields of the province of Rio Grande do Sul to the Carboniferous period, although the coal itself has more the aspect of being the product of a Secondary formation.

The three species which I propose describing in this paper are new forms belonging to the genera *Flemingites*, *Odontopteris*, and *Noeggerathia*. The most interesting of the three is the species of *Flemingites*, of which there are a large series of specimens of the stems and foliage, as well as of the detached sporangia. The characters of the species are as follows:—

Flemingites Pedroanus, sp. nov. Stem lepidendroid, scars small, obovate, without any markings; base of the petiole permanently attached to the stem; leaf slender, linear; venation parallel. Fruit a cone (?) the scales of which support numerous roundish sporangia.

I have, at the suggestion of Mr. Plant, associated with this interesting fossil the name of Dom Pedro II., Emperor of Brazil, who has on many occasions rendered such substantial aid to scientific investigators, as to have laid students of science under a debt of gratitude to him.

Some years ago (GEOL. MAG. Vol. II. p. 433) I established the genus *Flemingites* on the fragment of a cone which exhibited the relation of the small round sporangia so abundant in many coal-beds to their supporting organisms. There were no indications, in the only specimen I then had, of the plant on which the cone was borne, though it was evident from the structure and arrangement of the parts that it was the fruit of a form of *Lepidodendron*. I have since seen more perfect specimens from Burdick House in the collection of the British Museum, and from the Newcastle Coal-field belonging to Mr. J. Duff of Etherly. In my recent examination of the rich collection of Coal plants in the Newcastle Museum I found that the specimen figured in Lindley and Hutton's Fossil Flora, plate x. fig. 1, as a form of *Lepidostrobus variabilis*

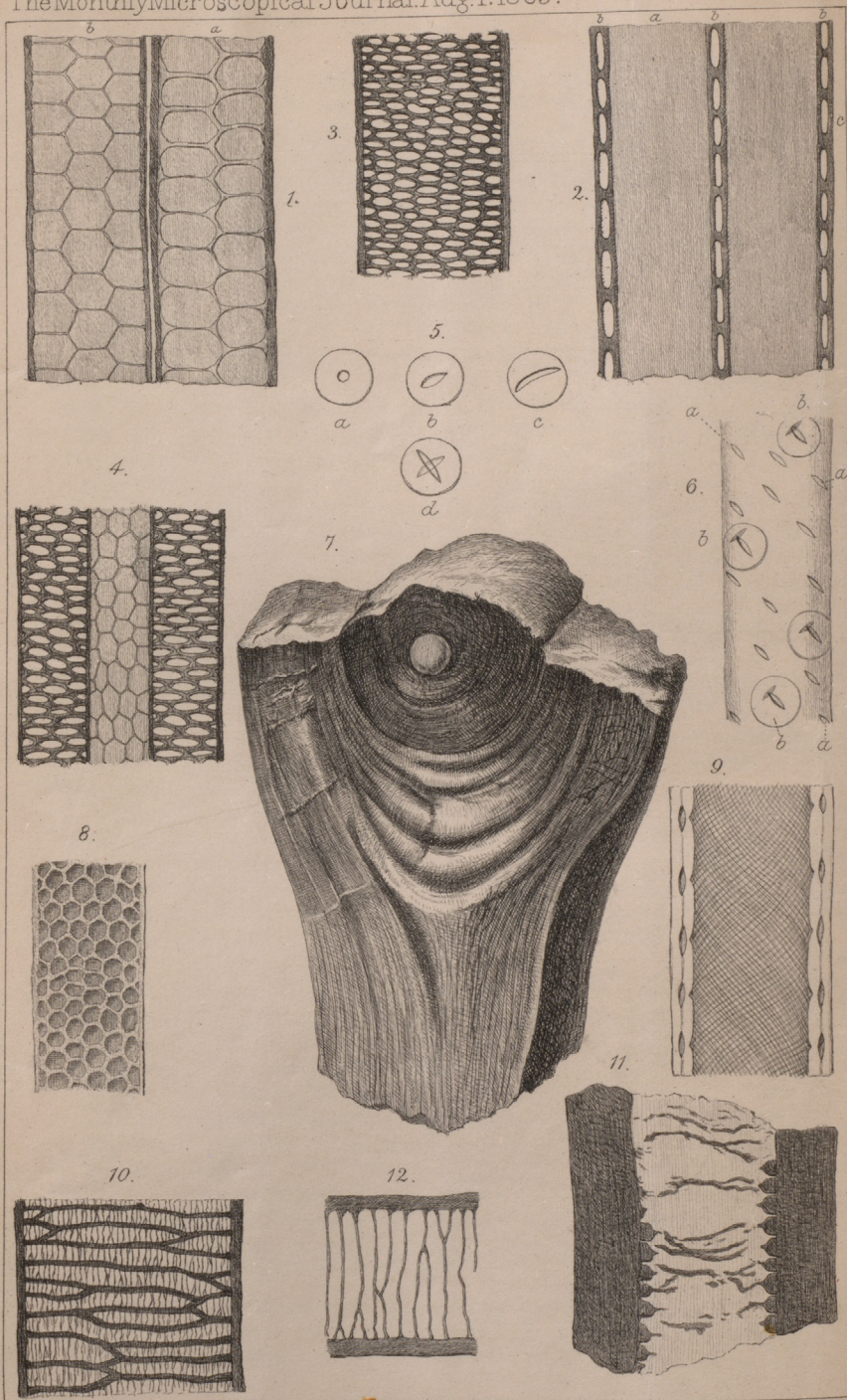
is really a specimen of *Flemingites gracilis*. In passing, I may say that this supposed species was made the receptacle for all indistinct and badly preserved specimens of such cones; the *variable* appearance of the specimens arising from their belonging to different species, and even, as it now appears, to different genera. In all the specimens, however, of *Flemingites* which I have examined I have seen no indication of the branch or tree on which they were supported, and the characters of the genus have been consequently confined to those of the cone. It is not a little interesting that the materials for completing our acquaintance with the fossil should be brought from South America,—a continent which, as far as I know, has not hitherto yielded any palæozoic fossil plants. The examination of the plate and of the description given will show, however, that the one organ wanting in the specimens from Brazil is the cone on which to a considerable extent I founded the genus. The sporangia abound, and though the co-relation of these organs with the lepidodendroid stem depends not upon direct observation but upon induction, yet that induction is so conclusive that it appears to me to place the matter beyond doubt.

The small round sporangia belong, as far is known either to *Sigillaria* or *Flemingites*. They abound in these Brazilian shales, and the only plants associated with them to which they could belong is that which is described in the diagnosis of the species. The arrangement of the leaf scars and the form of the leaf conclusively establish that this is not a *Sigillaria*. Among Mr. Plant's small collection there are over twelve different specimens of the stem, with numbers of sporangia scattered over the surface of the fragments on which they are preserved, and in one specimen several sporangia occur among the mass of true leaves which remain attached to the end of the branch, though not related to them as in the described cone of *Flemingites*.

The spiral arrangement of the leaves on these stems also agrees with the arrangement of the fruit-bearing leaves on the cone, so that there can be no doubt that the stems belong to *Flemingites*. They have the ordinary aspect of the stems of *Lepidodendron*, the scars being arranged in a spiral order. There are nevertheless points of considerable importance by which the two forms can be distinguished. The scars are small, approaching in size and form those of *Lycopodiolites cordatus*, Sternb. (Flora d. Vorwelt, tab. lvi. fig. 1), from Yarrow in Durham, a fossil which has been overlooked by subsequent authors, except that Professor Morris, who never overlooks anything, records it in his Catalogue of British Fossils under the name of *Lycopodites cordatus*. In the Brazilian fossil the scar is not *cordate*, but perfectly rounded on its upper margin (see enlarged scars, Pl. V. Fig. 11). But the most important character in respect of the scar is that it presents no impressions from an articulating surface like what is seen in *Lepidodendron*. This arises from the fact that the bases of the petioles permanently invested the stem, the leaves disarticulating at a line about a quarter of an inch along the petiole from the stem surface. A somewhat similar structure is described by Corda in his genus *Lomatophlojos*

¹ Prof. Morris has shown me specimens of Corda's *L. crassicaule* from English strata, and I have a second species from the beds of volcanic ash in Arran to which I have given the name of *L. Wunschianus*, after my friend Mr. E. A. Wunsch, of

24



Auctor del Tuffen West sc.

W. West imp.

Exogenous Stems from Coal-Measures.

Dr Dawson
with the authors kind regards

II.—*On the Structure and Affinities of some Exogenous Stems from the Coal-measures.* By W. C. WILLIAMSON, F.R.S.,
Professor of Natural History in Owen's College, Manchester.

THE generic term Dadoxylon, originally introduced by Endlicher, has long been used in a vague manner by phytologists. It has been applied to a large number of woody stems, common in the Coal-measures, very few of which have any claim to rank in the genus. As defined by Endlicher and Brongniart, the genus is characterized by "les rayons médullaires étroits, simples composés d'une seule lame de tissu cellulaire;" and further, it has "les punctuations des fibres ligneuses disposées en plusieurs séries alternantes entre elles, et prenant par pression la forme d'aréoles hexagonales."*

In 1851 I described the structure of some forms of Sternbergia,† and pointed out the apparently coniferous character of the woody zone surrounding the pith. I demonstrated the existence of rows of discs on the woody fibre arranged as in the living conifers; and concluded that the plants under consideration were true examples of Endlicher's genus Dadoxylon. Since the publication of that memoir, numerous specimens of woody stems have been found,

EXPLANATION OF PLATE XX.

- FIG. 1.—Vertical section of two fibres of Dadoxylon, from Coalbrook Dale.
" 2.—Tangential aspects of the same.
" 3.—Vertical section of part of a reticulated vessel of *Dictyoxydon Oldhamium*.
Mr. Butterworth's cabinet.
" 4.—Tangential section of two vessels of the same, separated by a medullary ray.
" 5.—Varieties of discs from the vessels of *Cycas revoluta*.
" 6.—A vessel from the same.
a. pitted tissue.
b. glandular discs.
" 7.—Fragment of a stem of *Dictyoxydon*, reduced one-half.
" 8.—Reticulated fibre from a tangential section of *Araucaria imbricata*.
" 9.—Fibre from a tangential section of *Thuja Donniana*.
" 10.—Part of a scalariform vessel from the inner cylinder of a *Lepidodendroid* plant.
" 11.—Vertical section of a *Dictyoxydon*, showing the Sternbergian pith. Mr. Butterworth's Cabinet.
" 12.—Portion of Fig. 10 further magnified.

* 'Tableau des Genres de Végétaux Fossiles,' par Adolphe Brongniart, p. 76.

† 'Transactions of the Literary and Philosophical Society of Manchester.'

transverse sections of which exhibit a structure identical with that of living conifers; but longitudinal sections show that the vessels or fibres are altogether different from the glandular or discigerous type. Instead of bearing rows of discs, and only on the surfaces of the vessels parallel with the medullary rays, their entire walls are covered with reticulations formed by the deposition of lignine *in the interior* of the vessels. All the specimens which have been latterly collected have been of this character; hence some of the most experienced phytologists came to the double conclusion that whilst the plants in question were true Dadoxylons, both Endlicher and myself had mistaken the internal reticulations of the fibres for the lenticular discs of true glandular fibre. Had this explanation been correct, we should have been left without any true coniferous wood in the Coal-measures. But it is not correct, as I shall now proceed to demonstrate.

Fig. 1 represents two fibres from my now celebrated specimen from Coalbrook Dale. The surfaces shown are those parallel to the medullary rays, and it will be seen that these surfaces are *entirely covered* in every fibre with discoid areolations. In some instances (Fig. 1, *a*) there are two vertical rows of these areolæ: the mutual pressure of their inner contiguous margins of which gives them a somewhat hexagonal form; but in other examples, as at Fig. 1, *a*, there is a distinct interval between the discs. In Fig. 1, *b*, we have three such vertical rows: the centre row, especially, having the hexagonal form to which M. Brongniart refers in his description of Dadoxylon. The only point in which these structures differ from the similar ones of living Araucarian conifers is the absence of the central dot in each disc. Of this I have never been able to detect a trace.

2 Fig. 2 represents two similar fibres as they appear in a tangential section of the stem. The surfaces (2, *a*) are here entirely smooth, being free alike from discs and reticulations. But between the contiguous fibres (2, *b*) we have a beaded structure revealing the discs of Fig. 1, seen in section. The fibre-walls (Fig. 2, *c*) are very distinct, and afford the clearest proof that the discs are *external* to the fibre, as in recent conifers. There cannot be the slightest room for doubting that, whether the fructification of the tree was or was not coniferous, we have here a modification of true glandular or discigerous pleurenchyma. But if we turn to the more abundant examples of the so-called Dadoxylons, we shall find an altogether different structure.

Fig. 3 represents a fibre of the plant which Mr. Binney has designated *Dadoxylon Oldhamium*, and which, in the specimen figured, exhibits* the most magnificent instance of reticulated

* This specimen is from the rich cabinet of Mr. Butterworth, of High Crompton, near Oldham.

fibre with which I am acquainted. The fibres are unusually large, having constantly a diameter of from $\frac{1}{200}$ to $\frac{1}{400}$ of an inch. The reticulations cover the surface of the fibre, each areola being from $\frac{1}{1000}$ to $\frac{1}{2000}$ of an inch in diameter.

Fig. 4 represents part of a tangential section exhibiting the surfaces of two fibres parallel to the exterior of the plant. The fibres are separated by one of the large medullary rays, with its multiplied vertical rows of cells, and which constitute one of the striking features of this remarkable species. This section demonstrates what I have already affirmed, *viz.* that the reticulations cover equally the entire circumference of the interior of the tube, and are not confined, like the areola of coniferous fibres, to its lateral surfaces. These two figures represent reticulated fibres as seen in several distinct plants found in the Coal-measures. Whether these prove to be different species of one genus, or whether they will require more than one genus for their reception, remains to be seen. But certainly none of them can be regarded as Dadoxylons, since they belong to an altogether different type of structure. In the general *arrangement* of their tissues, whether of pith, wood, or bark, they correspond very closely with the true conifera, but we have no evidence that they were conifers.

Since these plants with reticulated fibres can no longer be recognized as Dadoxylons, they must either be assigned to some other existing genus, or have a new one instituted for their reception. The only existing genera which approach them are *Palæoxylon* and *Pissadendron*—the first of which was founded by *Pruce* Witham, and the last by Brongniart, for the reception of some of Witham's plants. All these are described by Brongniart as possessing true coniferous fibres, which, if correct, would exclude the specimens under consideration. It is possible that some of the former may belong to reticulated types—especially *Palæoxylon*—but, since they are not so defined by the founder of the genera, they must for the present be left amongst the conifers, though they may be doubtful ones.

It appears necessary, therefore, to establish a new genus for all the plants whose woody cylinders consist of reticulated fibres; and the name of *Dictyoxylon* appears an appropriate one for it. I should propose for the present to include in this genus *all* the reticulated types—whether their medullary rays consist of one or of several vertical series of cells. At some future time their further separation into two or more genera may be requisite.

I have already called attention to the fact that the hexagonal and almost circular discs of the fibres of *Dadoxylon* (Fig. 1) exhibit a plane surface, the central dot common in recent conifers being absent. The absence of this dot led the late Robert Brown, some years ago, to reject my conclusion, that the fibres in question

were of the coniferous type—neither of us at that time being aware of the demonstration that the tangential section would afford. I think I now see my way to an explanation of the absence of the dot. The question has a sufficiently important bearing upon the hypothesis of development of one tissue out of another, and, *pari passu*, of one plant out of another, to give it importance.

In studying the microscopic tissues of the Cycadeæ, I have for some time been convinced that the discigerous vessels in *Cycas revoluta*, usually supposed to be of a coniferous type, were in some measure modifications of scalariform tissue. I have now found numerous vessels from the above plant, which renders the fact certain, since they exhibit discigerous tissue at one end of the vessel, whilst it becomes scalariform at the other. My views on this point, when promulgated in private correspondence with some botanical friends, were at once rejected by them; but there is no reason for questioning their correctness. I was not aware, however, when I came to this conclusion, that I had been anticipated by the late Mr. Don, in a paper which he read before the Linnean Society in 1840. The question is of some importance, since it affects the possibility of a glandular coniferous fibre being developed out of a reticulated one.

There exists amongst geologists some misconception respecting the true nature of a glandular disc, which consists of two very distinct elements, *viz.* the circular or hexagonal areola and the central dot. The outlines of the former vary chiefly according to the mutual pressure to which they are subjected. The latter variously appear as a small circular dot (Fig. 5, *a*), an oblong one (Fig. 5, *b*), which is sometimes so linear as to stretch across a great part of the disc (Fig. 5, *c*); and occasionally they assume a regular (Fig. 5, *d*) or irregular crucial shape (Fig. 6, *b*). The simple dot is due to a deficiency of the lignine lining the rest of the interior of the vessel, and is in no respect different from the pits of a pitted or porous vessel. But the circular disc or areola is external to the tube, consisting of a lenticular depression on the exterior of the wall of the fibre. That there is some connection between these two objects, when first formed, is obvious, from the constant presence of the dot in the centre of the areola, wherever the latter exists in recent plants. Thus the coniferous disc consists of two elements, one of which is internal to the primary wall of the vessel, whilst the other is external to it. The former may exist without the latter, as is the case in all porous or pitted vessels; but, as I have just observed, the latter never exists without the former, in the fibres of recent stems. Fig. 6 represents part of a scalariform vessel from *Cycas revoluta*, where the ligneous deposit has been so extended, that the oblique, transverse, thin spaces separating the bars of lignine, are reduced to mere oblong "pits" (Fig. 6, *a*), but where

the oblique parallelism of the original type of structure is still distinctly preserved. In this vessel a few of the pits are surrounded by an areola (Fig. 6, *b*), forming a true coniferous disc. In this individual fibre the addition of the areola is accompanied by a corresponding addition to the central dot, giving it an irregular crucial form, which does not exist in the "pits" that are not so furnished; demonstrating that the addition to the oblong dot converting it into a crucial one is external rather than an internal—such additions, however, are exceptional, though not rare. What causes determine the selection of special dots for areolation is uncertain; but we have here a manifest illustration of the process by which a spiral or scalariform vessel may be gradually transmitted into a glandular or discigerous one, and of the way in which the "pits" of the former structure regulate the positions of the discs of the latter.

It appears clear that in my *Dadoxylon* (Figs. 1 and 2) we have the outer lenticular disc, but not the internal deposits, converting the fibre into a pitted tissue. Hence the absence of the central dot in each areola, affording a new instance of the differences existing in the combinations of the elementary tissues in fossil as compared with recent plants, to which I have elsewhere called attention. In the stems of all the true conifers the discs are confined to the lateral surfaces of the fibres, parallel with the medullary rays—an arrangement to which those of *Dadoxylon* are no exception. I have observed that, in every recent conifer which I have studied, the "pits" opposite the discs (which are often converted into pores by the absorption of the wall of the vessel), also exist opposite each medullary ray, and there only, indicating some correspondence in the functions of the discs and the rays.

Whilst *Dadoxylon* thus appears to furnish the lenticular disc or external element of the coniferous fibre, I think we may regard *Dictyoxylon* as supplying a modification of the internal deposits, and thus possessing some relationship to the conifers. That the general aspect of the wood has been coniferous is shown by Fig. 7, which represents a specimen in my cabinet from the Lancashire Coal-measures. It is a portion of a large stem through which there passes a branch or "knot;" the undulations of the woody layers immediately below the branch too closely resemble those of a roughly-split pine-log to be overlooked. In the centre of the branch there appears a section of a rather large pith.

In estimating the true significance of the reticulated deposits of lignine in *Dictyoxylon*, we must recall the varied character of these internal deposits in recent conifers. They assume the simplest form in the common deal and other allied plants, where a continuous layer of lignine lines the tube, being wanting only, as already pointed out, opposite the glandular discs. In addition to this, in the common yew a second and more internal deposit exists,

in the form of a delicate spiral thread winding round the tube at wide intervals. In many of the Thujas and other Cupressinæ, an immense number of such threads line the previously thickened tube, and, running in opposite directions, cover its interior with a fine network. Fig. 9 represents a fibre of this kind from *Thuja Donniana*.* A further advance is shown in an example of *Araucaria imbricata* which I examined some years ago, and of which I fortunately preserved a section, since I have never since been able to detect the same structure in other plants of this species. Many of the fibres exhibit the appearance represented in Fig. 8, a reticular deposit of translucent lignine lining their interior, closely corresponding with that of Dictyoxylon. This fact appears to me to have some significance in relation to the affinities of the Dictyoxylons; since it is the only instance in which I have detected a similar structure in a living conifer. Why I fail to find the same structure in other examples of this species I cannot discover. Having made the preparation myself, I know it to belong to the plant in question; besides which, its other features are identical with those of corresponding sections of this *Araucaria* which I have made more recently. Be the cause of this anomaly what it may, the specimen remains to demonstrate that, under some conditions, the ligneous deposits of the conifera assume a reticulate form. All the known modifications of reticulate vessels were long ago shown by Meyen to be modifications of the ordinary spiral vessels—a fact of which the fossil-plants of the Coal-measures afford ample proof. Figs. 10 and 11 represent a portion of a scalariform vessel from a Lepidodendroid plant from the Coal-measures, probably a *Lomatophloos*.† We here have a condition intermediate between the simple scalariform vessel and the reticulate one of Dictyoxylon. In this example there is a peculiar feature which I have observed both in young twigs and in old stems of the plant, viz. a number of delicate vertical lines of lignine, usually simple, less frequently branched, connecting together the contiguous transverse bars of the vessel. Fig. 12 represents a few of these vertical bands further enlarged. I am not aware that this very curious modification of the scalariform vessel has been hitherto noticed.

The examples quoted suffice to show how variable are the modifications of the elementary spiral fibre amongst living conifers, and the reticulations of the vessels of Dadoxylon present but one more variation of the same primary type. From this we may conclude that Dadoxylon and Dictyoxylon separately possess the

* I have found the same structure in some fossil stems from the Cretaceous beds of Missouri.

† This plant is evidently identical with that described by Mr. Binney in the 'Phil. Trans.,' under the name of *Sigillaria vascularis*. I am convinced that it was not a *Sigillaria*, but a form allied to *Lepidodendron*, as stated above.

two elements of external discs and internal deposits which, when combined, constitute the coniferous vessel. The Darwinian would find no difficulty in concluding that the pollen of one of these plants might fertilize the ovules of the other, and thus produce, at some later period, structures in which there combined the two elements that are severed in the vessels of *Dadoxylon* and *Dictyoxylon*.

It is evident that both the above genera possessed in some instances, if not in all, piths of the Sternbergian type. Fig. 11 represents a beautiful vertical section of a *Dictyoxylon* from Mr. Butterworth's cabinet—in which the Sternbergian pith is very well displayed—the discoid laminae extending completely across the medullary cavity. This specimen is also remarkable for the regularity of the laminae, as well as for the peculiar thickened aspect their section exhibits near the walls of the medullary space.

When we consider how abundant these large exogens—especially the *Dictyoxylons*—are in the Coal-measures, it becomes remarkable that we have hitherto been unable to identify either their foliage or their fructification. I cannot believe that the latter assumed the form of recent cones, or such would have been common amongst other Carboniferous fossils, because of the readiness with which such structures are preserved. This is shown by the abundance of *Lepidostrobus* in these beds. It seems to me not improbable that *Trigonocarpon* may have constituted the fruit of one of these genera. Dr. Hooker has already expressed his conviction that it was the fruit of a conifer allied to the modern *Salisburia*: from its abundance in many districts, it must have belonged to one of the more common trees of the Carboniferous period. This would point to *Dictyoxylon*, which is abundant in the Lancashire districts, where *Trigonocarpons* are common, as constituting the parent stem from which the latter had fallen.

I would observe, in conclusion, that I have very little confidence in any determinations respecting fossil plants, excepting such as are based upon *internal structure*: all the modern classifications of living plants rest upon this basis, and it is the only safe guide amongst fossil ones. Of course its indications require to be checked by considerations of external form; but the former must be primary, and the latter but secondary aids. We rely upon the ~~former~~ when the latter is not to be obtained, but only then.

latter *former*

two elements of external force and lateral pressure which would surround the entire vessel. The latter would have no difficulty in containing the contents of the vessel, and the pressure of the contents would be the same in all parts of the vessel. The pressure of the contents would be the same in all parts of the vessel. The pressure of the contents would be the same in all parts of the vessel.

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ON
SOME FOSSILS
FOUND IN
THE EOPHYTON SANDSTONE
AT LUGNÅS IN SWEDEN.

BY
J. G. O. LINNARSSON.

WITH THREE PLATES.

TRANSLATED FROM THE ÖFVERSIGT AF KONGL. VETENSKAPS AKADEMIENS
FÖRHANDLINGAR, MARCH 10, 1869.

STOCKHOLM,
P. A. NORSTEDT & SÖNER
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1888

No other part of Sweden affords more favourable opportunities of studying the earliest fossiliferous deposits and their relations to each other than Vestrogothia with its unusually complete, undisturbed and in many natural sections exposed series of layers. Its two lowest principal layers, consisting of sandstone and alum-slate, are to be referred to the Cambrian system, if that system, as proposed by Sir Charles Lyell, Salter and others, be extended over the »primordial zone», which is easily distinguished by its organic remains from the overlying Silurian deposits. This sandstone has long been known as the oldest layer of Vestrogothia above the fundamental gneiss. Traces of seaweeds were found in it by our earlier geologists, and caused it to receive the name still commonly used of Fucoid sandstone. Deposits of the same period are distributed over large parts of Scandinavia, and Professor Angelin, who like his predecessors had found them to be the oldest portion of the whole »transition formation» of Scandinavia, included them all in his regio Fucoidarum, no other fossil having as yet been found in them. For the rock prevailing in Norway, which has not as yet afforded any fossils, Norwegian authors have proposed the denomination of the »Sparagmite stage», which has also been adopted by Professor Torell.

Until lately few additions had been made to our knowledge of the organic remains preserved in the deposits of the regio Fucoidarum. Beside the seaweeds Annelid burrows were found in it several years ago, but nothing was known of the existence in it of any other fossils, and it was generally assumed that very few fossils were to be expected in a layer of an age so remote, and that the rock itself was not capable of preserving, in a sufficiently distinct condition, the remains of such organisms as might have been living at the time of its deposition. Accordingly until late years very little attention had been directed to the Fucoid sandstone of Vestrogothia, and I had accordingly no great hope of any new discoveries, until I succeeded two years ago in finding a *Lingula*. Some time afterwards Professor Torell published his excellent geognostical and palæontological description of all the coeval rocks of Sweden¹⁾ and of the remarkable discovery, made by himself and Dr J. A. Wallin, of a comparatively highly organized plant, the *Eophyton Linnæanum* Torell, in these oldest deposits.

¹⁾ Bidrag till Sparagmitetagens geognosi och palæontologi. Lund 1868.

Since through these important researches of Professor Torell due attention has been drawn towards the oldest sandstone of Scandinavia, it becomes desirable to know with accuracy its age in relation to deposits in foreign countries and especially to the English formations, upon which the division into periods of the older palæozoic time now in use has been founded. At present no certain conclusions can be drawn from the organic remains, these being still so imperfectly known. It is necessary then to rely chiefly on the stratification, which can be ascertained with facility and accuracy in Vestrogothia better than anywhere else. Sir R. Murchison, who places the »primordial zone» in the lower Silurian system, refers to that system not only the alum slate of Vestrogothia, which apparently belongs to the primordial zone, as defined by Barrande from its Trilobite fauna, but also its sandstone layer¹⁾. Agreeing with Professor Torell²⁾ I believe however the latter to correspond with the »Longmynd group» of England, which is also considered by Sir R. Murchison as Cambrian, and according to the classification of Sir Charles Lyell forms the lower part of the Cambrian system of England. Like the Longmynd formation, the sandstone layer of Vestrogothia reposes on gneiss, which we have every reason to believe to be of Laurentian age. The alum slate lying above the sandstone layer completely corresponds with the Lingula-flags, which in England overlay the Longmynd formation. In the alum slate of Sweden, as in the Lingula-flags of England, two principal divisions are found, the well characterized fauna's of which Professor Angelin was the first to distinguish as the regio Conocorypharum and regio Olenorum. The older of these regions, the regio Conocorypharum, is characterized chiefly by the genera *Paradoxides* and *Conocoryphe* (*Conocephalites*), while the genus *Olenus* appears later; thus it is distinctly equivalent to the »Lower Lingula-flags» or »Menevian group» of England. The layers which lie above and below the sandstone layer of Vestrogothia being thus equivalent to those which bound the Longmynd formation, there is at least great probability that these deposits belong to the same period, and that the whole regio Fucoidarum is to be regarded as a representative of the lower part of the Cambrian system. If that be not admitted, it must be supposed that the regio Fucoidarum has no equivalent in England, and that Sweden wants every deposit from the earlier Cambrian period. For such a supposition however no sufficient reason can be afforded. The occurrence of plant remains cannot be regarded as such, at least so long as nothing corresponding has been known from the upper Cambrian, and Brachiopods have now been found also in the Longmynd formation. As even the Longmynd formation is said to contain one or perhaps more Brachiopods common to the Lingula-flags³⁾, the break between these formations cannot be very considerable, and we have thus additional

¹⁾ Davidson, On the earliest forms of Brachiopoda etc., Geol. Mag. 1868.

²⁾ Russia in Europe and the Ural Mountains, Vol. 1, p. 16.

³⁾ L. c., p. 2.

reason to give to the Cambrian period a longer duration than Sir R. Murchison has assumed. This circumstance and the great dissimilarity between the faunæ of the upper and lower Lingulaflags has induced some English writers to refer to the lower Cambrian system not only the Longmynd group, but also the lower Lingulaflags¹⁾. Accordingly the regio Conocorypharum should also be referred to the lower Cambrian system. The great geognostical resemblance however between the regio Conocorypharum and the regio Olenorum makes it more suitable, if a tripartition of the system (into a lower, a middle and an upper stage) be not preferred, to refer them both to the upper division, at least till some closer palæontological relation, than any hitherto shown, shall have been discovered between the former and the regio Fucoidarum, or between the lower Lingulaflags and the Longmynd formation. While thus referring, with Sir Charles Lyell, both portions of the »primordial zone», characterized by Professor Angelin, to the upper Cambrian system, I still think that the »Tremadoc group» is to be excluded from that system, and, together with its nearest equivalent in Sweden, the regio Ceratopygarum of Professor Angelin, to be regarded as the lowest portion of the lower Silurian.

The sandstone layer of Vestrogothia belongs as a whole to the regio Fucoidarum, but in some other parts of Scandinavia there are deposits of sandstone also belonging to the younger Cambrian period. Thus in Norway the »Hoejfelds Kvarts» forms a part of the primordial zone, the stage 2 of Professor Kjerulf²⁾. In Öland, at the base of the alumslate layer, lies a »calcareous quartz-schist»³⁾ in which the earliest genera of Trilobites have been found, and which by reason of its fossils has been referred by Professor Angelin to his regio Olenorum, but which, with greater show of reason, might be referred to the regio Conocorypharum. In Vestrogothia the same forms meet in the lowest part of the alum-slate, to which the quartz schist of Öland thus is equivalent.

On geognostical as well as upon palæontological grounds two divisions may be distinguished in the sandstone layer of Vestrogothia. In the lower, which is seldom seen in any natural section, the rock is hard, usually thin-bedded; in the upper, which is in many places exposed and has chiefly given rise to the names of Fucoid sandstone and regio Fucoidarum, it is softer and often thickbedded. At the very limits of the adjoining layers the sandstone is of an anomalous composition. At the limit of the gneiss it has the appearance of a conglomerate and contains also some felspar grains. The uppermost sandstone which lies immediately beneath the lowest alum slate contains a great deal of pyrites, and sometimes, as at Hunneberg, of clay also. These anomalous portions of the layer are very thin, being hardly more than one or two feet in thickness.

¹⁾ Cfr. Th. Belt, On the »Lingula-flags», or »Festiniog Group» of the Dolgelly District. Geol. Mag. 1867, p. 493 et sequ.

²⁾ Kjerulf, Stenriget og Fjeldlæren, p. 212.

³⁾ A. Sjögren, Anteckningar om Öland. Öfversigt af K. Vet. Akad. Förhandl. 1851.

The lower parts of the sandstone layer, although not overlooked by earlier writers, have, owing mainly to the researches of Dr Wallin and to Professor Torells descriptions of the fossils collected by the former, attracted a greater degree of attention, and it was through their works that I was led to make myself acquainted with them.

The Lugnås¹⁾ mountain offers the best opportunity of observing the lower division of the sandstone layer and its contact with the underlying gneiss, that is to say, the line of demarcation between the Cambrian and the Laurentian system. For that reason that locality has often been visited by geologists, but their views respecting the position of the limit are very different. From the olden time millstones have been quarried on a large scale in many places at the foot of the mountain, out of a rock containing the ingredients of granite and gneiss, but in which the felspar has partially been converted into kaoline. According to some writers this rock is a weathered granite or gneiss, and as such referred to the Laurentian system, or the »fundamental rocks»; others have believed it to be an Arkose formed by the mechanical decomposition of a granitic or gneissose rock and the subsequent cementation of the components. According to this opinion it would constitute the lowest portion of the sandstone layer and thus belong, together with the overlying sandstone, to the Cambrian (respectively Silurian) system, or the lowest part of the »transition formation». Hisinger hesitates between these two opinions; sometimes he names the rock a »rotting» granite or gneiss²⁾, but sometimes he says that »the millstone bed may be perhaps properly regarded as a granitic transition Arkose separated from the fundamental rock or the gneiss by a thin quartzose layer»³⁾. Sir Roderick Murchison believes the rock to be a Silurian Arkose, constituting the lowest part of the sandstone layer⁴⁾. But Dr Wallin, in his detailed and accurate description of the layers of the Lugnås mountain⁵⁾, has clearly shown, that the millstone rock is nothing but a variety of the common gneiss of the district, caused by the partial weathering of the felspar, and by no means, as the true Arkose, a sandstonelike rock. In visiting the millstone quarries of Lugnås last autumn, I felt convinced, almost at the first glance, of the truth of Dr Wallins determination. The mica scales are often seen to be arranged in wellmarked laminæ, usually dipping almost vertically, so as to produce a more or less distinct gneissose structure. Besides this the rock, as stated by Dr Wallin, increases downwards in hardness and resembles more and more the unchanged gneiss of the neighbourhood.

Thus it is above the millstone bed, that the oldest Cambrian deposit commences. The all but horizontal sandstone layer overlies unconformably

¹⁾ Pronounce: Lungnose.

²⁾ Anteckningar i Physik och Geognosi, Vol. IV, p. 48, 49, (1828).

³⁾ Anteckningar, vol. V, p. 67, (1831).

⁴⁾ Russia in Europe etc., vol. I, p. 167. Siluria, 4th ed., p. 347.

⁵⁾ Bidrag till kännedomen om Vestgötabergens byggnad. Lund 1868.

the nearly vertical strata of the millstone gneiss. In the quarries its lower division only is exposed. The rock nearest to the gneiss is, as before mentioned, a conglomerate, the sandstonelike cement of which contains larger or smaller rounded fragments of quartz and grains of felspar, the latter sometimes being, as in the millstone gneiss, converted into a kaolinic powder. In the fourth volume of his »Anteckningar»¹⁾ Hisinger has given a tolerably accurate description of this conglomerate, but he says afterwards, erroneously, that the millstone bed is in immediate contact with a fine-grained sandstone²⁾. The conglomerate is usually concreted into one mass with the millstone gneiss, but the limit, as may be expected from the different nature of the rocks and, above all, from their unconformable stratification, is very distinct. As yet no fossils have been found in it.

The thin conglomerate is followed, often without any very distinct line of demarcation, by the main mass of the lower sandstone, which is fine-grained, hard, greyish, and reddens in the air. Except in its undermost parts, its layers are very thin. It is interbedded with thin layers of a greenish-grey shale. Sometimes the sandstone, owing to a greater number of mica laminæ, assumes a schistose structure. Already Hisinger and Sir R. Murchison have described this sandstone and the shale alternating with it (»bluish-grey clay» Hisinger, »greenish-grey shale» Murchison). Dr Wallin has not only pointed out all its petrographic characters, but also remarked that it contains a peculiar Lethæa, and for that reason, on the suggestion of Professor Torell, has termed it Eophyton sandstone, reserving the name of Fucoid sandstone for the upper and softer parts. It is especially in the deep and numerous quarries on the northeastern side of the mountain that sections of the Eophyton sandstone are exposed, but the limit next the Fucoid sandstone proper is never denuded there and has not been observed in any other place. The thickness has therefore not been ascertained; Dr Wallin has found it to be at least 30 feet.

It was in this sandstone that Dr Wallin during the summer 1867 discovered the *Eophyton Linnæanum* Torell, and in the following year he added the *Arenicolites spiralis* Torell. Last autumn I visited Lugnås, and collected the fossils I am now going to describe. The rock, being very finegrained, has preserved very distinct casts of the plants and animals which lived in, or were swept into, the water where it was deposited, so that the most delicate parts can often be distinguished with accuracy. The knowledge however to be gained from the materials hitherto obtained is far from being satisfactory, and the interpretations must often be uncertain. Still I have thought it advisable not to delay publishing my observations, as every contribution that may throw some light on so remote a period, can hardly fail to be acceptable.

¹⁾ P. 49.

²⁾ Vol. V, p. 67; Vol. VI, p. 60.

ARENICOLITES SPIRALIS TORELL.

The worm described under this name by Professor Torell at the last meeting of the Scandinavian Naturalists in Christiania, is one of the commonest fossils, especially in the shale. The spirally curled form, which has given rise to the name, is easily recognized and is very constant. Its relations to the numerous burrows which are found along with it, are difficult to decide. The thickness — almost the only character which in this case is to be relied upon — is in the latter nearly the same as in the spiral form.

LINGULA (?) MONILIFERA n.

Of this species, with the exception of a nearly complete and very distinct cast of the outside of the one valve, pl. VII, fig. 1 and 2, I found only a few fragments. The inner parts are not visible in any specimen, and the generic determination therefore cannot be settled, but by the size and the general form and, above all, by the sculpture of the shell the species is easily distinguished from all the Brachiopods with which I am acquainted. In the cast the apex itself is not visible and one cannot therefore decide whether it is formed by the dorsal or ventral valve. The shell would seem to have been oval and very much depressed, except near the apex, where the sides are more sloping. The length and breadth are about 22 millimeters. The shell is ornamented with extremely close and fine longitudinal, slightly diverging, raised and beaded lines, of which about five may be counted within the breadth of a millimeter. The lines of growth are apparent only near the front margin. Judging from the thickness of the detached slabs in which this species was found, it would seem to have made its appearance already in the undermost layer of the Eophyton sandstone, and may thus be the earliest Mollusk hitherto known.

In a slab of schistose sandstone I found a Brachiopod, which in the sculpture of the shell bears some resemblance to the preceding species, but in other respects, as far as one can judge from the indistinct fragments, is widely different. On the surface of the slab lie two shells, of which the margins only are preserved, and even those incompletely, the middle part being totally effaced. The contour seems to have been almost circular with a diameter of about 50 millimeters. The shell, like that of *Lingula monilifera*, bears raised, beaded lines, but these lines here seem to be directed towards the centre of the shell; near the circumference their distance from each other is somewhat less than a millimeter. From the general form of the shell this species may most likely be supposed to be a *Discina* or *Trematis*.

EOPHYTON LINNEANUM TORELL.

Bidr. till Sparagmitetagens geogn. och pal., p. 36, t. II, f. 3, t. III, f. 1—3.

It is to be hoped that Professor Torell will soon communicate some further observations about this remarkable but as yet not sufficiently known species. In the mean time I may venture upon the following remarks. With the materials I have hitherto obtained it is hardly possible to give a full specific description, and I must therefore confine myself to describing separately some of the specimens collected. In figure 3 of pl. VII is shown a piece of sandstone with two specimens lying parallel and close together. The one to the left agrees, as far as I can recollect, with the specimens exhibited by Professor Torell himself, which I had an opportunity of seeing at the last meeting of Scandinavian Naturalists in Christiania. It is a regularly convex fragment of a stem, of equal breadth throughout, and perfectly straight, 170 millimeters long and about 25 millimeters broad, with a height of about six millimeters¹). Along its whole length it bears a large number of regular furrows, say 35, the breadth of which is nearly the same as that of the intervening raised ribs. Towards the sides both the furrows and ribs are generally somewhat larger, and especially a few millimeters from the margin one broad and deep furrow is to be seen. Besides some ribs raised above the others run at nearly regular distances from one another. These higher ribs are for the most part arranged in pairs and separated by a comparatively broad furrow. Such a pair runs along the middle, and several others are more or less discernible on the right side, this arrangement being less conspicuous on the left side. The smaller ribs and furrows running between the larger are exceedingly fine, and it has not therefore been possible to represent them all distinctly enough in the figure, since even in the original they are to be distinguished only with difficulty. All the ribs and furrows are straight except in the uppermost part, at *a*, where those in the middle are gently bent asunder, as though near the origin of a branch. On the sides of the stem, at *b* and *c*, are to be seen awl-like appendages, the organic connexion of which with the stem is somewhat uncertain.

The specimen on the right hand is depressed and mutilated and not visible throughout its whole breadth, which must have been considerable, the preserved portion being more than 25 millimeters broad. The ribs and furrows are much coarser and much less regularly arranged. On the left side they are comparatively equal and small in size, though coarser than in the former specimen. Further to the right hand the breadth of the furrows is much larger, sometimes amounting even to three millimeters. The ribs are always several times narrower, the coarser among them being often divided. Even in this specimen they are for the most part straight, but near the left margin the outer ones, at *d*, bend outwards, probably

¹) In the figure the inner part of the right side appears more depressed than in the original.

where a branch has been affixed. Close above this flexion the sculpture is effaced; when the furrows in the upper part again appear, they run quite straight.

Fig. 4 in the same plate represents a specimen, somewhat weathered, the outlines of which therefore are not quite distinct. Its visible breadth is about 15 millimeters. In the upper part a branch, or a leaf (?) runs out, the base of which forms a ridge obliquely crossing the whole breadth of the stem. Its free portion is bent almost straight upwards, parallel to the stem, but broken so near the base, that its form cannot be conjectured. The longitudinal furrows of the stem are close and narrow, but in consequence of the weathering, sometimes not very distinct. In the lower portion they are gently and irregularly bent, then straight, until immediately beneath the oblique ridge they are suddenly bent in the same direction as the ridge; above this they are quite straight. In the appendicular organ no furrows are visible, but that perhaps depends partly on the matrix being there more coarse-grained. This specimen agrees in many respects with the righthand one in fig. 3, and in order that the conformity between the two in the course of the furrows may be more conspicuous, it has been drawn inverted in fig. 4^a by the side of its presumed analogue in fig. 3. At *d* in fig. 4^a as at *d* in fig. 3 the ribs to the left bend outwards, and close above this point there are in neither specimen any furrows, and when these reappear in the upper part, they are in both straight, the right hand furrows not partaking of the flexion, but running without interruption. — Though probably not belonging to this fossil, a small conical tubercle, *a* in fig. 4, seems worthy of attention, arising as it does in the very margin of the stem and being surrounded by an annular eminence.

The plate VIII represents a slab which evidently has been long exposed to the air, so that in some places the sculpture is not so conspicuous as in that just described. It contains several larger and smaller fragments of stems. They are all distinguished from the foregoing by their inferior breadth, which is but from four to six millimeters. The furrows are in all somewhat conformable and narrow, though for the most part larger than those in the first-mentioned specimen. Some of the stems are depressed, but in some of them the height above the surface of the slab is nearly as great as the breadth; the more convex ones are often angular. The largest specimen has a length of about 100 millimeters. It is divided into two branches of equal size, making an angle of about 40°, and having the same breadth as the common stem. The left branch seems to be somewhat tapering, but that depends no doubt on its gradually sinking in the matrix. Between the branches lies a fragment, *a*, the extremities of which seem to be abruptly cut off at their contact with the branches. In the axil of the branches an oblong, irregular, convex mass, *b*, runs out, which however shows no trace of structure. The common stem is slightly bent and has its hinder part sunk in the matrix; but in its continuation

there lies a very convex stem fragment, *c*, of similar form. From beneath the anterior part of this another depressed stem fragment, *d*, projects with more obscure outlines. Whether they are coherent or not can not be seen, a formless mass covering the point at which they meet. — Among the other specimens the following ought to be especially noticed. At *e* a short but large fragment is observed. Its posterior section shows some small cavities, disposed obliquely one above the other at nearly regular distances, which may perhaps be interpreted as traces of the inner structure. To the right lies a longer and narrower fragment, *f*, which has possibly cohered with another, *g*, of which only a small portion is preserved, in the very margin. Both are there bent, as if they had been united outside the present margin of the slab. — By the side of these lies a specimen, *h*, with deep furrows and sharp ribs. In this, as in some others, the furrows sometimes show a slight trace of a transverse articulation, as if each furrow had consisted of a row of small excavations, but this may have arisen from the weathering of the slab. — At *i* a fragment is seen, which is remarkable for its great convexity and distinctly angular shape. — An irregular raised body, *k*, marked by two parallel rows of tubercles, is probably of organic origin, and is suggestive perhaps of the presence of terrestrial animal life.

Several other slabs not figured contain specimens of *Eophyton Linnæ-anum*, they give however but little information. One of them has almost the whole surface covered with fragments of stems, some of which are branched; but the weathering has made them too obscure to be described.

It seems premature to speculate on the affinities of this fossil, which bears so little resemblance to forms previously known, and ampler materials are no doubt required in order to come to any certain results in this respect. Its organic origin cannot reasonably be questioned, and hardly any doubt can exist as to its belonging to the vegetable kingdom. If it were not of vegetable origin, it could not be interpreted otherwise than as the track of an animal. Such a supposition is contradicted especially by its being branched; a track cannot be supposed to have taken such a form as that shown for instance in pl. VII fig. 4. And even apart from the branching, this interpretation can hardly be maintained if the characteristic furrows be considered, at least I have never seen a description of any tracks with which this fossil could be compared. If the vegetable nature of *Eophyton* be granted, the difficulty of deciding to which group it is to be referred still remains. This difficulty is augmented by the scarcity of fossil plants in the oldest deposits, that might enable us to draw a comparison. From the whole Cambrian and the greater part of the Silurian system no remains of other plants than Algæ have hitherto been obtained. That the *Eophyton* cannot be referred to that class is however evident. Several eminent algologists have examined the fossil and they have all unanimously and with the greatest certainty declared that it cannot have any affinity with the Algæ. It is then among the vascular Cryptogams and Monocotyledons that the

relations of *Eophyton* are to be looked for. Professor Torell refers it to the latter, and though its fanerogamous nature be not yet fully ascertained, its general habitus in many respects undeniably reminds us of them. He presumes however also a near relation to *Cordaïtes*, a genus referred by several authors to the Lycopodiaceæ. This opinion is founded on the resemblance supposed by Professor Torell between the leaves of *Cordaïtes* and *Eophyton*. It is however doubtful, whether the organs interpreted as leaves in *Eophyton* are really such. Judging from the figures given by Professor Torell, they seem to be the same parts which I have described as portions of stems, and which, from their branching not resembling that of compound leaves, their often very convex shape, etc., I could not regard as leaves. In the restoration given by Dawson¹⁾ the stem of *Cordaïtes* has very short joints, and if that be true, there is still less reason to assume a nearer relation between *Cordaïtes* and *Eophyton*, the stem of the latter, at least in the specimens hitherto found, showing no articulation. Thus, though a great uncertainty still remains as to the place of *Eophyton* in the natural system, it can hardly be doubted that it is of a far higher organization than any plant hitherto known from the oldest deposits.

With regard to the mode of fossilization of the *Eophyton*, it seems probable that the plants immersed in the water made impressions on the mud upon its bottom, and that, after the plants themselves had been dissolved, their impressions were filled with sand. In this manner the fact is to be explained that one specimen often is, as it were, cut off when in contact with another. We must accordingly suppose that the mutilated specimen has made an impression, and that afterwards the other has been laid across and partially obliterated this impression.

EOPHYTON TORELLI n. sp.

Although it is very uncertain whether this species have any nearer relation to the preceding typical species of the genus *Eophyton*, I have thought fit to describe it under the same generic name. Extensive researches into the plant remains of the *Eophyton* sandstone are still necessary, before any certain generic characters can be given, and there is therefore reason in keeping them all provisionally under the name *Eophyton*.

Eophyton Torelli is much scarcer than *E. Linnæanum*; at least I have found it only on one slab of sandstone, some parts of which are represented in the plate IX.

In fig. A is shown a stem fragment about 90 millimeters in length. The foremost half, the breadth of which is 10—12 millimeters, is very convex and distinctly angular, so that four sides are visible. Both the outer sides are almost vertical, — in the figure the left cannot be seen, but it is of about the same breadth as the right. The upper sides are gently sloping and somewhat concave, the left being broader than the right. The

¹⁾ Acadian Geology, second ed. p. 458.

hinder part becomes gradually more and more depressed, and consequently the breadth increases, until it attains 19 millimeters. The surface is generally smooth, except that on the hinder part some very faint traces of longitudinal furrows are seen. The most characteristic parts of this specimen are four scales, which seem to be spirally arranged round the axis, but, as far as visible, at unequal distances. The first, *a*, which is placed on the left margin of the depressed portion, is broadly lanceolate and has a length of about 8 millimeters and a maximum breadth of 4 millimeters. At a distance of 15 millimeters, on the middle ridge between the upper sides, another scale, *b*, of about the same shape and size is placed. About 30 millimeters in advance a similar organ, *c*, projects from the upper lefthand side, and a fourth, *d*, is seen, as it were, hanging down from the angle of the outer right side. The scale at *c* seems to have been cleft in such a manner, that some organ which had for the most part been destroyed, has been rendered visible.

Of the nature of the objects represented by the other figures, and of their relation to the specimen just described, it is at present difficult to form an idea. In order to draw attention to them however I have thought fit to give figures of them. Their presence in the same slab makes it to a certain extent probable that some of them at least belong to the stem described above.

In fig. B is shown an oblong body strongly convex, with a very wrinkled and rough surface. It might perhaps be conjectured to have been a spicate inflorescence. Its length is 45 millimeters, the breadth about 10 millimeters. From the right side, at *a*, two narrow, oblong linear bodies run out, one across the base of the other. Their outlines are very distinct on the outer side, on the inner not quite so much so. Both have along the middle a faint furrow, in the continuation of which is seen a faint threadlike ridge, *b*. A third body of the same form but shorter and broader lies at their base. In B' they are represented somewhat magnified.

In the anterior part of the fig. C a cylindrical body *a* is seen, perhaps analogous to *a* in fig. A. In the posterior part at *b* there are three conical tubercles, arranged in a row, round which the surface of the stone is finely striated.

The objects shown by the portion D of the same slab are for the most part very obscure. On the left side are seen several more or less elevated parts *a*, marked by faint longitudinal furrows; they are probably parts of some portions of a depressed stem. On the right side is seen a broken, cylindrical, wrinkled body, somewhat resembling the one represented in fig. B, together with some straight linear ribs, while behind them there is a narrow tube, at the side of which lies an oblong body *b*, that may be compared with *a* in C. Of none of these objects will I venture any interpretation.

RHYSOPHYCUS DISPAR n. sp.

There occurs in the Eophyton sandstone more frequently than any other a strange fossil, bearing a close resemblance to certain forms described by Hall¹⁾, Billings²⁾ and Dawson³⁾ under the generic names of *Rusophycus*⁴⁾ and *Rusichnites*. It always consists of a system of linear eminences or ribs, arranged symmetrically and more or less transversely on each side of the middle line. The form most closely agreeing with the descriptions given, especially of *R. bilobatus* (Vanuxem) Hall from the Clinton group, and *R. Grenvillensis* Billings from the Chazy limestone of North America, may be considered as the type. It is an oblong body, very convex and broader at one of its ends, which may be called the anterior; it is divided into two symmetrical lobes by a longitudinal furrow, which in the hinder portion is narrow and shallow, but increases forwards in size, so that the front ends of the lobes are completely separated from each other. The width of the whole fossil does not always increase regularly and continuously; before the middle the enlargement usually takes place more slowly and sometimes entirely ceases. Even when the width of the whole increases continuously, the lobes taper before the middle, in consequence of the increasing breadth of the longitudinal furrow. Each lobe has a multitude of close, rather regular narrow ribs, which in the hinder portion meet in the median furrow, forming an angle, the top of which is directed backward. In the middle, where their direction is often suddenly altered, they are almost at right angles with the median line. In the anterior portion, where the ribs of the two lobes do not touch, their projections, if drawn out, would form an angle with the top directed forwards. In consequence of this change in their direction the ribs are crowded together on the sides and diverge inwards. The dimensions, absolute as well as relative, are varying, but not to any great extent. The length I have found to vary between 50 and 80 millimeters. The greatest breadth is sometimes but little less than the length, but it does not usually exceed two thirds of the length. The height is greatest in the middle, being sometimes equal to a third of the length. — There is no trace of an axis. Hall considers that he has found such an organ in the *R. bilobatus*, but, as stated by Dawson, the supposed stem is undoubtedly nothing but a tube of a worm. Even in the Vestrogothian species such tubes are sometimes seen to issue here and there between the ribs, but never in such a situation, as to be mistaken for branches or stems.

The ribs are but comparatively seldom united into such convex bodies as are here described. They are usually extended almost horizontally;

¹⁾ Palæontology of New-York, Vol. 2, p. 23, 24.

²⁾ Palæozoic Fossils of Canada, Vol. I, p. 101.

³⁾ On the Fossils of the genus *Rusophycus*, Canadian Naturalist, Oct. 1864, 363.

⁴⁾ According to the derivation the name is to be written *Rhysophycus*, or, with Eichwald (*Lethæa Rossica*, Vol. I, p. 54) *Rhyssoptychus*.

sometimes whole slabs are covered with such systems. The ribs are in this case straight or but slightly bent, more nearly parallel with each other and usually almost at right angles with the median line. The opposite ribs are seldom in contact, and the two halves are therefore entirely separated. Even the approximate ribs of the same lobe are seldom contiguous. Sometimes transitions between this form and the one above described are seen. Thus in one specimen the ribs are more crowded and meet at the median line; each lobe is slightly convex, but of the same height throughout its whole length, while the typical form is highest in the middle and sloping both forwards and backwards. The specimens of the horizontally expanded form hitherto collected have a length of from 15 to 80 millimeters; the number of the ribs varies according to the length, but depends also in some degree upon their being more or less crowded. The breadth is between 15 and 30 millimeters, but is in general nearly the same in different parts of the same specimen. Annelid burrows often have lifted or depressed some ribs; sometimes they are seen to wind between the ribs, now over, now under them.

Although the specimens hitherto obtained do not exhibit a complete series of transitions, it is highly probable that the convex and the more horizontally expanded form belong to one and the same species, more especially as Dawson has found two analogous forms of *R. Grenvillensis*.

According to Hall and Dawson the allied American forms always occur on the under side of the strata, where these are reposing on shale, and are thus casts of impressions once formed upon the soft clay. Without doubt the same is also the case with the fossil occurring in Vestrogothia, but I have had no opportunity of directly verifying it.

The genus *Rhysophycus* is still one of the least understood; it has not even been ascertained, whether it be of vegetable or animal origin. Besides, as now defined, it includes objects too heterogeneous. Thus *R. clavatus* and *subangulatus* Hall and *R. embolus* Eichw. seem to have a closer relation to *Arthropycus Harlani* (Conrad) Hall than to the other forms referred to *Rhysophycus*. *R. dispar* differs from *R. bilobatus* and *Grenvillensis* chiefly in the greater regularity of the ribs and of the change of their direction, and in the considerably increased breadth of the longitudinal furrow. In other respects those three species have so much in common, that they must be considered as closely related, and interpreted in the same way. I can find no reason with Hall to refer them to the Algæ. If they were of that origin, we might expect to find a stem or axis. Dawson, who has especially examined the *R. Grenvillensis*, believes the more horizontally expanded form to be the cast of the tracks of some Trilobite, and the convex to be the cast of a hole excavated by the Trilobite for shelter or repose. He therefore alters the generic name into *Rusichnites*. This interpretation does not seem an unreasonable account of the horizontal form, but it does not explain so well the convex form;

especially since it is difficult to understand how the ribs could have got the direction they have in *R. dispar*. The further objection that no Trilobites or other Crustacea are found in the lower Cambrian sandstone of Vestrogothia, is of less importance, as from the discoveries already made it is probable that even Trilobites lived when this layer was formed. Salter¹⁾ thinks the species referred to the genus *Rhysoptychus* to be short forms of the genus *Cruziana* of d'Orbigny²⁾, and there certainly seems to be a great affinity between the two. D'Orbigny simply refers his *Cruziana* to the articulata, Salter considers it as annelid tubes, somewhat coriaceous. D'Orbigny's name has priority.

On account of its plant remains the Eophyton sandstone is considered by Professor Torell as probably a freshwater deposit. That this cannot be the case is proved by its containing also Brachiopods. From the frequent occurrence of ripplemarks and rain-prints it may be supposed to be a shore-deposit.

The upper division of the sandstone layer, or the Fucoid sandstone proper, is not so poor in fossils as has hitherto been supposed. In an earlier memoir³⁾ I have mentioned the discovery of a *Lingula* at Djupa-dalen near Karleby. During the last summer I searched in vain for the same species, but in place of it I collected several specimens of another *Lingulide*. Among the specimens obtained not one is quite complete, and they exhibit no decisive generic characters. The rather singular sculpture of the shell however is admirably well preserved, and on that account the species may be named *Lingula* (?) *favosa*. The shell is depressed and has almost the form of a sector of a circle, somewhat exceeding a quadrant; its length is about 5 millimeters, the breadth being a little more, about 6 millimeters. The anterior half of the shell bears some sharp lines of growth and a few punctiform pits, but otherwise it is smooth. Behind the middle there follows a space closely beset with small excavations. At the very apex, which in all the specimens is more or less damaged, the shell seems again to be smooth. The colour, at least outside, is of a whitish blue.

¹⁾ Bigsby's Thesaurus Siluricus, p. 2.

²⁾ Voyage dans l'Amérique méridionale, III, 2, p. 30, pl. 1, f. 1, 2; 1842. — Marie Rouault altered the name to *Frœna*, Bull. Soc. Géol., 2de Sér. VII, 729.

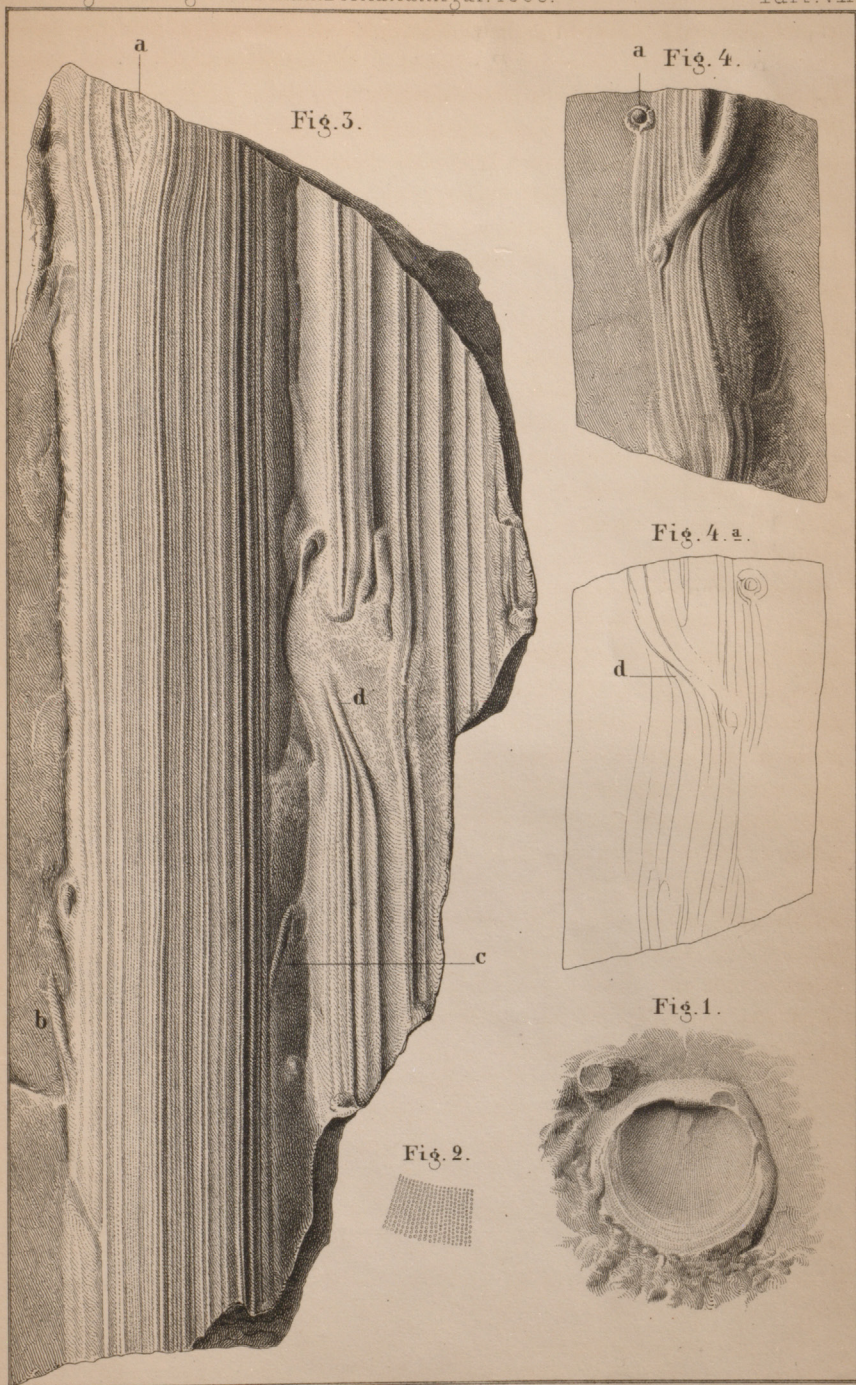
³⁾ Bidrag till Vestergötlands Geologi. Öfvers. af K. Vet. Akad. Förh. 1868.

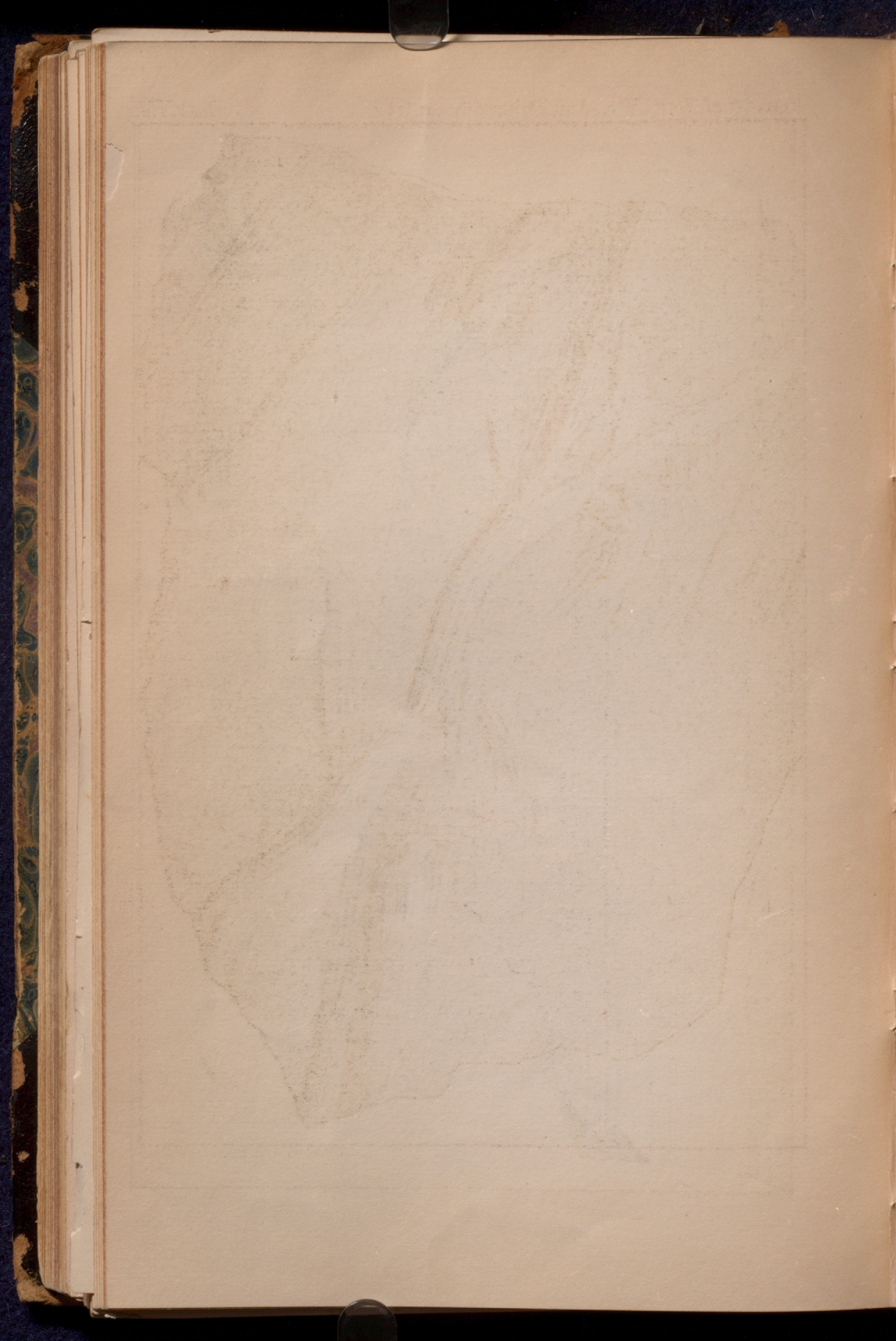
Explanation of the plates.

Plate VII. Fig. 1 and 2, *Lingula monilifera* n. — Fig. 3 and 4, *Eophyton Linnæanum* TOR.

Plate VIII. *Eophyton Linnæanum* TOR.

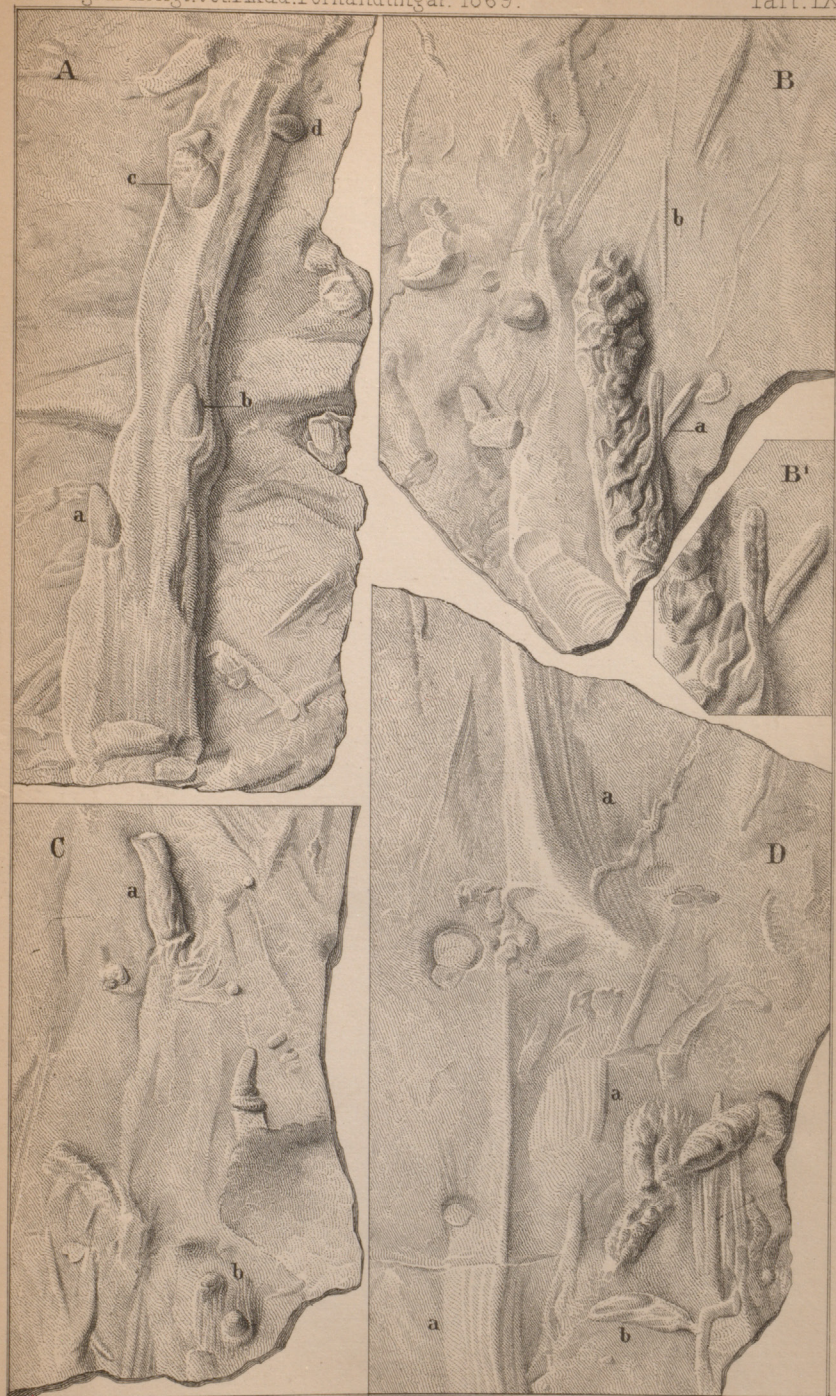
Plate IX. *Eophyton Torelli* LINNARSSON.

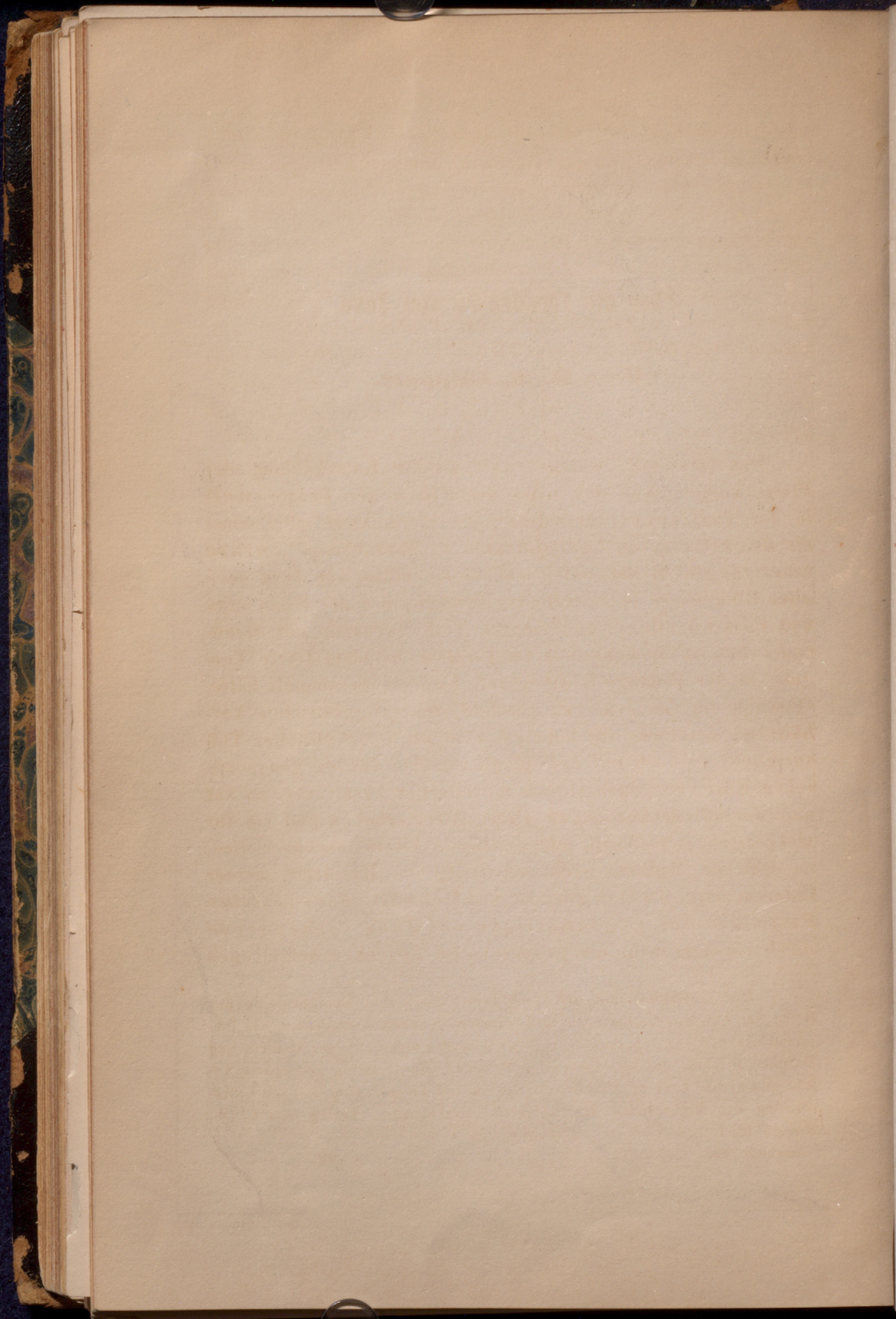






C.G.Höglind ad.nat.lap.insculpitt.





Über die Tertiärflora von Java

von

Herrn **H. R. Göppert.**

Das Interesse, welches sich an die Entscheidung der Frage knüpft, wie sich wohl die Flora der Tropenwelt in der Tertiärzeit verhalten habe, veranlasst mich, einst die Bearbeitung von Tertiärpflanzen zu übernehmen*, welche unser rühmlichst bekannter, um die Kenntniss von Java nach allen Richtungen hochverdienter JUNGHUHN aus der Basis einer 940 Fuss mächtigen, aus Meigel, Tuff, Sandstein mit Meerconchylien zusammengesetzten Terrasse bei dem Dorfe Tangung in der Preange-Regentschaft Tjandjur gesammelt hatte. Obschon die von JUNGHUHN geschilderten geognostischen Verhältnisse durchweg für höheres Alter als jetztweltlichen Tuff sprechen, er auch auf der später von ihm edirten geognostischen Karte von Java sie als mitteltertiär bezeichnet, so hat man doch Bedenken gegen dieses Alter erhoben und sie für viel jünger, ja vielleicht jetztweltlichen Alters ansehen wollen, zu welcher Meinung wohl unstreitig die Resultate meiner Untersuchung, die eine grosse Ähnlichkeit jener fossilen Flora mit der gegenwärtigen auf Java vorhandenen nachwiesen, mehr als geognostische Bedenken beigetragen

* Die Tertiärflora auf der Insel Java. Nach den Entdeckungen des Herrn FR. JUNGHUHN beschrieben und erörtert in ihrem Verhältnisse zur Gesamtfiora der Tertiärperiode von H. R. GÖPPERT, ord. Prof. der Medicin und Botanik, Direktor des bot. Gartens in Breslau. Mit 18 farbig gedruckten Tafeln und 170 S. Text gr 4^o. Herausgegeben auf Veranlassung und mit Unterstützung des Ministeriums der Kolonien. Gravenhage. Verlag von C. W. MIELING 1854.

haben mögen. Da sich aber ähnliche Verhältnisse auch bei allen europäischen und amerikanischen Tertiärfloren immer mehr herausstellen, so war es allerdings nicht nur an und für sich von Wichtigkeit, sondern auch für mich im Interesse meiner auf umfangreiche, vergleichende Arbeiten gegründeten Untersuchungen wünschenswerth, jenes für die tropische Tertiärflora gefundene Resultat noch weiter zu begründen.

Die von JUNGHUHN mir übergebenen Fossilien bestanden aus Blattabdrücken, verkieselten und verkohlten Stämmen.

A. Blattabdrücke.

Von drei verschiedenen Arten:

1) An der linken (südöstlichen) Seite des Tji-Bunithales (Distrikt Djampang wétan der Preanger Regentschaft Tjandjur) liegt das Dorf Tangung auf einem Vorsprunge, den die Wand des Brengbreng (der Bruchrand eines einseitig gehobenen Gebirgstheils) daselbst bildet. In geringer Entfernung vom genannten Dorfe fließt der Bach (Tji-) Gêmbong, nachdem er von der Brengbrengwand herab seinen schäumenden Lauf vollendet hat, in einem flachen, nur wenig vertieften Bette über den vorspringenden Theil der Wand, — über die Terrasse, worauf das Dorf steht. Sobald er sich aber dem Rande der Terrasse genähert hat, welche von dort noch 390' tiefer in die Sohle des Tji-Bunithales herabfällt, so verwandelt ($\frac{1}{4}$ Pfahl nordostwärts vom Dorfe*) sein Bett sich plötzlich in eine kleine, von steilen Seitenwänden eingeengte Kluft, welche den übrigen Theil des Gehänges bis herab in die Thalsohle durchschneidet. Die Kluft fängt mit einer Querstufe an, einer Wand, vor welcher der Bach als Wasserfall herabstürzt. Hier an dieser Wand ist es, wo man 940' unterhalb des höchsten Brengbrengrandes und 390' oberhalb der Thalsohle die Schicht entblösst findet, welche die Blattabdrücke enthält. Die Schicht besteht aus einer erdigen, Tuffgleichen Masse von dunkelgrauer, hier und da ins Bläuliche ziehender Farbe, die an der Oberfläche und, nachdem das Gestein gebrochen ist (durch Verwitterung) allmählich schmutzig gelbbraun wird, und worin viele 1 Linie bis 1 Zoll, seltener

* Ein javanischer Pfahl (Paal) ist 4800 rheinl. Fuss lang.

bis $\frac{1}{2}$ Fuss dicke, eckige, gleichgefärbte oder hellere Einschlüsse vorkommen, die sich wie vulkanische Steintrümmer darstellen, aber ebenfalls weich und schneidbar sind. Diese Masse ist sowohl an der Querstufe, vor welcher der Wasserfall herabstürzt, als an den Seitenwänden der Kluft, (die mit jener Stufe anfängt) deutlich entblösst, hat eine Mächtigkeit von 15' und ruht zunächst auf einem größern Conglomerate, das am Fusse der Wand hinter dem Wasserfalle, Bucht- oder Grottenartig ausgehöhlt ist, so dass unsere Schicht über dieser Bucht als Decke vorspringt. Einwärts von der Tangungsplatte, an der Brengbrenzwand, folgen auf diesen Tuff in der Richtung nach oben lockere Mergelschichten, die überhaupt in dem ganzen 940' hohen Schichtenverein, von dem die Tuffbank noch bedeckt ist, vorherrschen. Manche kalkige Mergel dieses Vereins sind reich an Meerconchylien,* doch kommen auch härtere Sandsteine darin vor. Sie fallen, wie die Tuffschicht, alle in einem Winkel von 15 bis 20° nach Südosten ein. Auf dem bebauten Vorsprunge selbst aber ist die Tuffschicht, wenn auch nicht überall, doch in der nächsten Umgebung des Baches, bedeckt von neuern Absätzen, von Bachanschwemmungen, die am Ufer entblösst horizontal auf einander liegen. Zuoberst bemerkt man eine fruchtbare Erdschicht, darauf folgt ein 5' mächtiges Geschiebelager und unter diesem liegt eine 3' dicke hellbraune Erdschicht, die den Tuff daselbst bedeckt.

Folgende Blattabdrücke, die bei weitem grösste Zahl der ganzen Sammlung, wurden hier gefunden, deren Abbildung sich auf den bezeichneten Tafeln des oben genannten Werkes zugleich mit den analogen Formen der jetztweltlichen Flora befindet.

* Auch das Kohlenflötz: L. 330, das weiter thalabwärts beim Dorfe Dugu vorkommt, hat zum Hangenden eine Thonschicht, die voll von zerbrochenen Meermuscheln ist, nämlich Bivalven: L. P. 422 des Leidener Museum's. Schon beim Beginnen meiner Arbeit sollten diese Conchylien baldigst beschrieben werden, wozu es aber bis jetzt noch nicht gekommen ist, daher mit das Schwankende über das Alter unserer Formation, der durch Bestimmung jener Fossilien bald ein Ende gemacht werden dürfte.

- Xylomites stigmariaeformis* m. Tab. IV, Fig. 27.
Flabellaria licualaefolia Tab. IV, Fig. 29.
Amesoneuron Calyptrocalix Tab. V, Fig. 31—33.
 — — *sagifolium* Tab. V, Fig. 35, 36.
 — — *dracophyllum* Tab. V, Fig. 38.
 — — *anceps* Tab. V, Fig. 39.
Cannophyllites Vrieseanus Tab. VI, Fig. 42, 43, 44, 46.
Musophyllum truncatum Tab. VII, Fig. 47.
Piperites Miquelianus m. Tab. VII, Fig. 48, 49.
 — — *Junghuhnianus* m. Tab. VII.
 — — *bullatus* m. Tab. VII, Fig. 51.
Quercus subsinuata Tab. VIII, Fig. 53.
 — — *laurophylla* Tab. VIII, Fig. 54.
 — — *castaneoides* Tab. VII, Fig. 56.
Ficus flexuosa Tab. VIII, Fig. 57.
Daphnogene javanica Tab. IX, Fig. 60.
 — — *intermedia* Tab. IX, Fig. 63.
Laurophyllum Beilschmiedioides Tab. X, Fig. 65 a und b, Tab. XI, Fig. 66 und 68.
 — — *viburnifolium* Fig. 65 c, Tab. X et Tab. XI, Fig. 69.
 — — *Haasioides* Tab. X, Fig. 65 d et Tab. XI, Fig. 70.
Apocynophyllum Reinwardtianum Tab. XII, Fig. 74 und 75.
 — — *nervosissimum* Tab. XII, Fig. 78.
Cornus benthamioides Tab. XIII, Fig. 79.
Magnoliastrum Michelioides Tab. XIII, Fig. 81.
 — — *arcinerve* Tab. XIII, Fig. 82.
 — — *taulamoides* Tab. XIII, Fig. 83.
Malpighiastrum Junghuhnianum Göpp. Tab. XIII, Fig. 84.
Rhamnus dilatata Tab. XIV, Fig. 88.

2) Im Innern des Distriktes Djampang kulon (Preanger Regentschaft Tjandjur), in der Nähe des Dorfes Pesawahan kommen in einer Schicht von gelblich braunem, thonigem Mergel, folgende Blattabdrücke von verschiedenen dicotyledonischen Baumarten vor: L. 351 bis 353, Nummer der Originale, die jetzt sämtlich im Reichsmuseum in Leiden aufbewahrt werden.

- Quercus castaneoides* m. Tab. VII, Fig. 56.
Ficus dubia Tab. VII, Fig. 59.

Diospyros dubia Tab. XII, Fig. 72.

Ceanothus javanica Tab. XIV, Fig. 87.

Celastrophyllum attenuatum Tab. XIV, Fig. 89.

— — *andromedaefolium* Tab. XIV, Fig. 91.

— — *olcaefolium* Tab. XIV, Fig. 92, 93 a.

— — *myricoides* Göpp. Tab. XIV, Fig. 93 b.

3) Im oberen Tji-Tjolangthale, namentlich am Ufer des Nebenbaches Tji-Pinang beim Dorfe Sêlogambé (Abtheilung Kuningan der Residenz Tjeribon) findet man einen bituminösen, äusserst mürben, zertrümmerten Sandstein, der eine Menge kleiner Adern und Nester von fossilem Harz: L. 344, und auch einzelne Kohlennester, in Kohle verwandelte, plattgedrückte dicotyledonische Laubholzstämme: L. 340, enthält.

Sehr interessant erscheinen auch die grossen Massen fossilen Harzes, welches theils in 1—6 Linien dicken Adern, theils in Nestern von 1—5 Linien Durchmesser sehr häufig, sowohl in den Kohlenflötzen, als auch in ihrer Nähe in den bituminösen Thon- und Sandsteinschichten vorkommt und unzweifelhaft, wie wohl kaum bemerkt werden darf, vegetabilischen Ursprunges ist. Es erscheint meistens bräunlich gelb von Farbe, an den Kanten durchscheinend, spröde, leicht in Stücke zu zerbrechen und in ein gelblich weisses Pulver zu bringen. Angezündet verbrennt es mit bituminösem Geruche unter starker schwarzer Rauchbildung. Das specifische Gewicht einer dunkelbraunen Varietät von Sêlogambé war nach JUNGHUHN's Bestimmung 1,57; das einer hellbraunen aus einem anderen Theile des Tji-Tjolang-Flussthalcs 1,80. Nach Versuchen, die BUNSEN von einem seiner Schüler, dem für die Wissenschaft und die Seinigen zu früh verstorbenen Dr. Phil. RICHARD COHN, anstellen liess, löste sich dieses Harz weder in Alkohol, noch in Äther und zwar weder bei gewöhnlicher Temperatur noch beim Kochen des Lösungsmittels, noch auch nach vorherigem Schmelzen des Harzes. Dagegen löste es sich leicht in Chloroform zu einer braunen, auf Papier einen schönen Firniss zurücklassenden Flüssigkeit, aus der durch Alkohol das Harz wieder gefällt wurde. Erhitzt schmolz es leicht und brannte angezündet mit einer hellen, russenden Flamme. Als Destillationsprodukte ergaben sich: ein flüchtiges

Öl von sehr intensivem üblem Geruch, ein brennbares Gas und eine saure Flüssigkeit, welche auf Bernsteinsäure geprüft, jedoch dieselbe nicht erkennen liess. Manche Sandsteine, wie die bei Sêlogambé sind von Tausenden feiner Adern und kleiner eingesprengten Theile dieses Harzes, nicht selten im Wechsel mit glänzend schwarzer Kohle, so ganz und gar durchdrungen, dass sie sehr spröde und zerreiblich geworden sind, wie unter anderm der L. Nro. 350 vorliegende Sandstein zeigt, in welchem, wie es scheint, ursprünglich cylindrische, jetzt etwas plattgedrückte, 2—3 Zoll lange und 1—1½ Zoll breite, zapfenähnliche Bildungen vorkommen, die ohne Spur von Struktur durchweg aus einem bröcklichen, mit Harz gemischten Sandstein bestehen. JUNGHUHN vergleicht sie mit den Blütenkolben mancher Freycinetien.

Bei vorliegenden Bestimmungen liess ich mich nicht durch flüchtige Vergleiche zufällig entgegnetretender Blätter, sondern durch lange Zeit hindurch fortgesetzte Untersuchungen der lebenden Flora Java's bewegen, deren nähere Kenntniss mir die reichen Sammlungen von DE VRIESE, BLUME, REINWARDT, ZOLLINGER u. A. damals gewährten, wie denn auch bei jeder abgebildeten fossilen Pflanze die ihr analoge lebende hinzugefügt ward. Aus diesen vergleichenden Untersuchungen ergab sich nun, dass fast für jedes wenigstens einigermaassen vollständig erhaltene Blatt auch das analoge nicht fehlte, wie z. B. für die merkwürdige *Scitaminea*, *Cannophyllites*, *Vrieseanus*, die *Alpinia nutans*. Fiederstücke von Palmen ähnelten *Licuala*, *Flabellaria licualaefolia*, den Kotang- und Fagusarten, für welche Reste bei der Unmöglichkeit sie nach den vorliegenden Exemplaren genauer zu bestimmen, die schon früher (Beiträge zur Tertiärflora Schlesiens 1851, S. 6) aufgestellte und auch von Andern anerkannte eventuelle Gattung *Amesoneuron* ebenfalls zum Rahmen diene; Eichen, Pfeffer- und Ficus-Arten wurden mit einiger Sicherheit erkannt. Unter den nach Verhältniss zahlreichen Laurineen befindet sich eine Art, die mit den unter dem Namen *Daphnogene* (*Cinnamomum Rossmässleri* HEER) als Leitpflanze unserer Braunkohlenlager dienenden Pflanzenresten die grösste Ähnlichkeit zeigt, vielleicht sogar identisch ist, worüber man aber bei ihrer unvollständigen

Erhaltung Gewissheit nicht erlangen kann. Eine zweite unserer Tertiärflora nahe stehende Art ist noch das *Apocynophyllum Reinwardtianum*, welche dem *Phyllites arcinervis* ROSSMÄSSLER aus der Braunkohlenflora von Allsattel in Böhmen hinsichtlich der eigenthümlichen Nervenverbreitung sehr verwandt erscheint. Ich verglich sie mit einer Apocynce mit *Melodinus scandens*. Obschon HEER die Ähnlichkeit unserer Blätter zugiebt, fühlt er sich dennoch veranlasst unsere Gattung nicht anzuerkennen, sondern ihre Arten mit *Ficus* zu vereinigen, was wohl nur dann zu billigen wäre, wenn die neue Benennung sich auf vollständige Sicherheit der Bestimmung gründete, was jedoch keineswegs der Fall ist.

Ich glaube, dass diese Arten sowie auch die Daphnogene ganz geeignet erscheinen, zu Anknüpfungspunkten mit unserer miocänen Flora zu dienen. Die unter dem Namen *Laurophyllum* beschriebenen Blätter ähneln sehr den noch auf Java lebenden Arten der Gattungen *Haasea* und *Beilschmiedia*.

B. Verkieselte oder verkohlte Baumstämme als Reste
ehemaliger tertiärer Wälder

finden sich häufig auf Java; ganz besonders in einer ziemlich ausgedehnten Gegend im Innern der Bantanischen Regentschaft Lebak, theils noch anstehend in den mit Thon-Sandstein und Mergellagern wechselnden Kohlenschichten, theils durch Ströme verschwemmt, entfernt von dem ursprünglichen Vorkommen, also auf secundären Lagerstätten. Nadelhölzer konnten unter ihnen nicht nachgewiesen werden; die noch mit charakterisirbaren Merkmalen versehenen Hölzer gehörten entschieden wahren Dicotyledonen an: zwei chalcedonirte *Miquelites elegans* Tab. I, Fig. 7 und Fig. 7a, und *Bredaea moroides* Tab. I, Fig. 3—5, sowie ein mit Kohle stark durchsetztes verkieseltes Stämmchen *Junghuhnites javanicus* Tab. II, Fig. 11—16 wurden beschrieben und abgebildet.

Aus den zahlreichen Kohlenlagern der Residenz Batam, die S. 23 und folgende meines Werkes nach JUNGHUHN näher angegeben werden, lagen ebenfalls viele Proben vor. Coniferen fehlten, nur Dicotyledonen waren unter ihnen vorhanden, welche sich nicht nur aus dem Äusseren Tab. III, Fig. 26,

sondern auch mittelst der von mir bereits im Jahre 1836 beschriebenen Methode durch Verbrennung der Kohle und Untersuchung der zurückbleibenden Asche leicht erkennen liessen, indem sie Kieselskelette von punktirten Gefässen und vielstöckigen Markstrahlen liefert.

Auch die an dem oben schon erwähnten Harze überaus reichen Exemplare, abgebildet auf Tab. II, Fig. 17, Tab. III, Fig. 18, gehörten in diese Ordnung. Stämme von baumartigen Farrn oder Palmen wurden ebenfalls vermisst, was allerdings befremdlich erscheint, nur ein fächerförmiges Blatt *Elabellaria licualaefolia* Tab. IV, Fig. 29, konnte als sicher von Palmen abstammend beobachtet werden. Von einigem Interesse war jedoch ein bituminöses den Pfefferarten der Jetztwelt sehr ähnliches Stämmchen *Piperites Hassharlianus* Tab. IV, Fig. 20—24, als die einzige Holzart, die auch unter den fossilen Blättern 2 Repräsentanten zählte.

Die gesammte also damals und man darf wohl sagen bis jetzt bekannte Tertiärflora Java's besteht aus 39 Arten folgender Familien:

<i>Fungi</i>	1 Art,
<i>Palmae</i>	5 Arten,
<i>Anomeae</i>	1 Art,
<i>Musaceae</i>	1 Art,
<i>Piperaceae</i>	3 Arten,
<i>Cupuliferae</i>	3 Arten,
<i>Moreae</i>	2 Arten,
<i>Laurineae</i>	5 Arten,
<i>Diospyreae</i>	1 Art,
<i>Apocynae</i>	2 Arten,
<i>Corneae</i>	1 Art,
<i>Magnoliaceae</i>	3 Arten,
<i>Malpighiaceae</i>	1 Art,
<i>Rhamneae</i>	2 Arten,
<i>Celastrineae</i>	5 Arten,
<i>Dicotyledonenstämme</i>	
unbestimmter Familie	3 Arten,
	39 Arten.

1 Cryptogame, 7 Monocotyledonen und 29 Dicotyledonen.

Wenn sich nun schon aus dem ganzen Inhalte der vorstehenden Mittheilungen ergibt, dass die geschilderten Ablagerungen jedenfalls der Tertiärformation, nicht der Diluvial- oder gar den jetztweltlichen Bildungen zuzurechnen sind, so müssen wir doch bekennen, dass wir wegen Mangel der Bestimmung der zahlreichen von JUNGHUHN an denselben Orten gefundenen Conchylien nicht zu entscheiden vermögen, zu welchen der drei Glieder der Tertiärformation sie gehören. Es war mir daher sehr erfreulich, aus den Mittheilungen unseres Reisenden Dr. FERDINAND Freiherrn von RICHTHOFEN, der vor 2 Jahren jene merkwürdigen Fundorte besuchte (dessen Bericht über einen Ausflug auf Java, Zeitschrift der deutschen geologischen Gesellschaft 14. Bd., 2. Heft 1862, p. 336) zu entnehmen, dass er den Schichtencomplex, in welchen jene von JUNGHUHN gefundenen Pflanzenreste vorkommen, der Tertiärperiode und zwar dem jüngeren Theil derselben zuschreibe. MONTLEY (*Quart. Journ. of London* 1853, S. 55) der die tertiären Braunkohlen-Bildungen von Borneo und der Ostküste Sumatra's untersuchte, fand ebenfalls ihre fossilen Reste den jetzt dort lebenden sehr verwandt, ja manche (2 Arten von *Barringtonia*) waren von derselben nicht zu unterscheiden, die Baumstämme gehörten, wie die von Java ausschliesslich, Dicotyledonen an, und zwar wie er glaubt Dipterocarpeen.

Von diesen so harzreichen Bäumen stammt auch seiner Ansicht nach das viele in den Kohlen vorkommende Harz, eine Vermuthung, die auch unsere oben angeführten Untersuchungen gewissermassen indirekt bestätigen, indem sich aus ihnen ergab, dass die harzführenden verkohlten von JUNGHUHN gefundenen Stämme wenigstens nicht Nadelholzbäumen, sondern Dicotyledonen angehörten. Vorläufig erscheint es als Hauptresultat unsrer Untersuchungen, dass die sonst in der Tertiärformation Europa's, Asiens und Nord-Amerika's so häufigen Coniferen in der tropischen Tertiärflora bis jetzt noch nicht entdeckt worden

sind und die Flora selbst eine auffallende Verwandtschaft mit der gegenwärtigen des Fundortes zeigt, manche Arten sogar mit ihr identisch zu seyn scheinen.

Anderwärtige wie später noch aus den Kohlenlagern von Java und Sumatra von dem Königl. Niederländischen Berghauptmann Herrn von GROOT geschickte Fossilien widersprechen diesem Resultate nicht, obschon ich vor Beendigung ihrer Untersuchung etwas Genaueres darüber noch nicht mittheilen kann.

Beiträge zur Kenntniss fossiler Cycadeen

von

Herrn Geh.-Rath Dr. **H. R. Göppert**

in Breslau.

(Hiezu Tafel II.)

Es gibt wenige Pflanzenfamilien, welche ungeachtet ihrer geringen Zahl an Arten das allgemeine Interesse so in Anspruch genommen haben, als die Cycadeen. Daher erscheint es insbesondere in einer Zeit, wo man den Ursprung der Vegetationstypen mit so grosser Aufmerksamkeit verfolgt, gewiss von grossem Interesse, auf ihr erstes Auftreten in der Reihe der Floren zurückzukommen, welche bis zur Gegenwart zu verschiedenen Zeiten auf unserem Erdball aufgetreten und auch wieder verschwunden sind.

Die Anwesenheit wahrer Cycadeen in den älteren Gliedern der paläozoischen Formation wurde bisher oft in Zweifel gezogen. * Bereits im Jahr 1843 beschrieb ich ein *Pterophyllum* aus den Thoneisensteinen der Steinkohlenformation Oberschlesiens unter dem Namen *Pt. gonorrhachis* ab, welches aber wegen der nicht gut gerathenen Lithographie zu Zweifeln Veranlassung gab. Inzwischen fühle ich mich aber um so mehr veranlasst, diese Bestimmung aufrecht zu halten, als ich im ober-schlesischen Thoneisenstein ein zweites, wenigstens stammverwandtes Exemplar

* Die von Miquel noch zu den Cycadeen gezogenen Trigonocarpeen und Rhabdocarpen gehören nach meinen neuesten Funden (Permische Flora, S. 270—71) nicht hieher, sondern zu den Palmen.

auffand, *Cycadites gyrosus*, und in der neuesten Zeit F. SANDBERGER ein ganz unzweifelhaftes *Pterophyllum*, *Pt. blechnoides* in der oberen Steinkohlenformation des Baden'schen Schwarzwaldes (Verhandl. des naturw. Vereins in Carlsruhe, 1864, 1. Hft. Tab. II, S. 30) entdeckte. Jedoch hat schon die noch ältere Culmperiode (untere Kohlenformation, Kohlenkalk, Grauwacke) eine Cycadee aufzuweisen, welche ich in dem der unteren Kohlenformation gleichalterigen Kohlenkalk zu Rothwaltersdorf in Schlesien auffand, wo sie mit den diese Periode charakterisirenden, thierischen Petrefacten vorkommt, *Cycadites taxodinus* m. In dem letzten Gliede der paläozoischen Reihe, in den unteren Gliedern der Permischen Formation oder der Dyas, mehren sich die Cycadeen, repräsentirt durch Stämme und Wedel. Bei den ersteren glaube ich die höchste Ausbildung der Structurverhältnisse dieser Pflanzenfamilie in der *Medullosa stellata* insbesondere wegen der in der Markröhre in Menge vorhandenen, ausgebildeten Holzcyylinder nachgewiesen zu haben (die Permische Flora, 1865, p. 208, Tab. XL, Fig. 2—5. Tab. XLI, Fig. 1—8. Tab. XLII, XLIII, Fig. 1, 2. Tab. LXIII, Fig. 1). In der nun folgenden Trias und noch mehr in der Juraperiode erreicht unsere Familie das Maximum von Arten, fehlt nicht in der Kreidegruppe, wohl aber fast gänzlich bisher in der Tertiärperiode, in der ich sie jedoch ebenfalls, und zwar schon vor 17 Jahren, ohne sie zu publiciren, unter den mir von dem gegenwärtigen Gouverneur von Grönland, Dr. RINK, im Jahr 1848 mitgetheilten, in Grönland bei Kook (70° n. Br.) gesammelten Pflanzen der Miocänperiode erkannte, ein ächter *Zamites*, *Zamites arcticus* (nicht *Pterophyllum arcticum*, wie es aus Versehen S. 174 der Zeitschrift der deutschen geolog. Gesellschaft, J. 1864, und der Permischen Flora S. 287 heisst), ein überaus interessantes Vorkommen, auf dessen höhere Bedeutung ich am Schlusse der Abhandlung noch einmahl zurückkommen werde. Zunächst lasse ich die Beschreibung der vier von mir genannten, hier abgebildeten Arten folgen.

Cycadeaceae.

Ich unterscheide und rechne hieher zwei Familien, die *Cycadinae*, welche den lebenden Cycadeen entsprechen, und die

Medullosen, welche als eine der Permischen Flora eigenthümliche Gruppe anzusehen sind und vielleicht später noch in mehrere Abtheilungen zerfallen (Permische Flora, p. 203) dürften.

Cycadites BRONGN.

Folia pinnata, coriacea, foliolis integerrimis lineari-lanceolatis lata basi insertis quandoque decurrentibus valide uninerviis nervis secundariis parallelis distinctis.

Von den früher von mir (1843), wie auch später noch von J. G. BORNEMANN (1856) und von G. A. MIQUEL (1861) zu dieser Gattung gezogenen Arten gehören *Cycadites salicifolius* PRESL. und *C. angustifolius* desselben Autors aus dem Braunkohlensandstein bei Altsattel in Böhmen nach UNGER und zwar ganz naturgemäss zu der Palmengattung *Phoenicites*. *Cycadites giganteus* HISING. und *C. zamiaefolius* STERNB. von Hör in Schonen jedenfalls zu einer *Zamites*-Art, wahrscheinlich zu *Z. distans*. *Cycadites linearis* BRONGNIART (*Tableau des genres fossiles* 1849, p. 61) scheint nur ein unvollständiges Exemplar von *Nilssonia elongata* zu seyn, *Cycad. cyprinopholis* GUILL. zu den *Lepidodendreen*, ähnlich *Lepidoflojos*, zu gehören. Es bleiben also nur sicher *C. pectinatus* BERGER aus dem Lias zu Coburg, *C. Brongniartii* RÖMER, *C. Morrisianus* DUNKER aus der Wealden-Formation bei Obernkirchen und *C. Nilssonianus* BRONGN. aus Hör in Schonen.

Cycadites taxodinus n. Tab. II, Fig. 1—3.

C. fronde pinnata, foliolis anguste linearibus approximatis substrictis patentibus acutis, nervo medio distincto basi incrassato rhachì crassissimae insertis.

In den dem Kohlenkalk an geognostischem Alter gleichen Schieferen zu Rothwaltersdorf bei Silberberg in Schlesien mit Producten und Spiriferen.

Nur in den beiden in natürlicher Grösse Fig. 1 und 2 abgebildeten Exemplaren vorhanden, welche ich schon vor vielen Jahren auffand, aber immer noch zu veröffentlichen zögerte. Die bei Fig. 1 und 2 zwei Zoll lange, aber bis vier Linien breite Spindel ziemlich flach, aber nach Verhältniss der kleinen Blätter ungewöhnlich breit, so dass ich lange zweifelte, ob sie dazu gehören dürfte, da sie überdiess nur auf einer Seite noch mit

Blättchen versehen ist. Inzwischen glaube ich, diess doch annehmen zu müssen und bitte, die Zeichnung in Folge dessen, nicht wie sie dasteht, sondern in verkehrter Lage betrachten zu wollen. Fig. 2. Bruchstücke einer zweiten Fieder, deren ebenfalls unvollständige Spindel auch nur auf einer Seite noch mit Blättchen versehen ist. Die Blättchen $\frac{1}{3}$ Zoll lang, dicht gedrängt an einander, mit $\frac{1}{3}$ der ganzen Breite starkem Mittelnerv, der, wie man bei einer Vergrösserung, Fig. 3, sieht, an der Basis sich noch mehr verbreitert, so dass an dessen Seiten kaum noch etwas Blattsubstanz sichtbar ist.

Von allen bisher bekannten fossilen und lebenden Arten weicht die vorliegende Art durch die so überaus breite Spindel auffallend ab. Die Gestalt der Blättchen erinnert einigermassen an *C. Brongniartii* DUNKER aus der Wealdenformation.

Cycadites gyrosus n. Tab. II, Fig. 4.

Ein Thoneisenstein bei Dubensko im Nikolaier Kohlenrevier in Oberschlesien.

In der natürlichen Grösse abgebildet; meiner Meinung nach ein in der Entwicklung begriffener Wedel oder Blatt, wie es bei der lebenden Gattung *Cycas* vorkommt. Die Spindel tritt hier nämlich in gerader Richtung hervor, die Blättchen rollen sich spiralförmig auf, wie das Fig. 5 abgebildete, in solcher Entwicklung begriffene Blattbruchstück von *Cycas revoluta* zu zeigen bestimmt ist. Die Spindel des Fossils ist von Blättchen zu Blättchen etwas ausgebuchtet, die Spindel der lebenden *Cycas* sehr steif und gerade. Eine Diagnose lässt sich füglich nicht aufstellen, an der Selbstständigkeit der Art aber nicht zweifeln, da die Kohlenformation bis jetzt noch keinen *Cycadites* aufzuweisen hat, daher der Specialname nur den Zustand bezeichnet, in welchem ich sie beobachtete.

Pterophyllum BRONGN. et GÖPP.

Fronde pinnatae vel profunde pinnatifidae, pinnulis approximatis tota latitudine adnatis patentissimis vel patentis, valde abbreviatis quadratis oblongatisve apice recte vel oblique truncatis, vel elongatis linearibus obtusis acutisve, nervis tenuibus aequalibus margini parallelis.

Pterophyllum GÖPPERT, über die fossilen Cycadeen in Verhandl. d. Schles. Gesellsch. v. J. 1843, S. 19; derselbe in der Permischen Flora 1865, p. 205.

ÜNGER, *gen. et spec. plant. fossil.* p. 286 *ex parte*.

BRONGNIART, *tableaux des genres de végét. fossiles* p. 65.

BORNEMANN, über organische Reste der Lettenkohle 1856, S. 57.

MIQUEL, *Prodr. syst. Cycad.* 1861, p. 29 *ex parte*.

GÖPPERT, Permische Flora 1865, p. 205—206, enthält meine gegenwärtigen Ansichten über *Pterophyllum*, worauf ich hiemit hinweise.

Pterophyllum gonorrhachis m. Tab. II, Fig. 6—8.

Pt. fronde pinnata, foliolis integris suboppositis patentissimis lanceolatis basi attenuatis adnatis remotis, rhachi subtriangulari per intervalla nodosa, nervis crebris distinctis tenuioribus distinctis.

Pterophyllum gonorrhachis GÖPP. Verh. d. schles. Gesellsch. vom J. 1843, p. 50, Tab. I, Fig. 6.

Thoneisenstein der oberen Steinkohlen-Formation zu Königshütte in Oberschlesien.

Die in der oben genannten Abhandlung enthaltene Abbildung war in der Lithographie sehr schlecht gerathen, daher ich nicht verfehle, hier eine bessere und zwar ebenfalls in natürlicher Grösse von 1 Z. L. zu liefern. Das Exemplar ist an und für sich ziemlich unvollständig erhalten, bei a der Wedel zerquetscht und ein anderer, noch unvollständiger, kreuzt sich mit ihm. Die Spindel läuft nach oben in eine stumpfliche Kante aus, die sich da, wo rechts und links Fiederblättchen sitzen, zu einem kleinen stumpflichen, nach allen Seiten sich gleichmässig abdachenden, knotenförmigen Höcker (daher auch der Specialname) erhebt, deren überhaupt 4—6 wohl erhalten sind. Die in dem Eisenstein scharf ausgeprägten, nur leider an der Seite meist beschädigten Fiederblättchen verschmälern sich gegen die von dem Knoten ausgehende und daher auch in der Mitte etwas erhabene Basis, obschon die in der Mitte befindlichen Nerven sich nicht durch grössere Dicke vor den übrigen auszeichnen. Fig. 7 u. 8 zeigen schwach vergrösserte Darstellungen derselben, Fig. 7 die

Beschaffenheit der Basis und Fig. 8 die des weiteren Verlaufes in die Blattfläche. Die Erhaltung des vorliegenden Exemplars lässt allerdings viel zu wünschen übrig, doch war es im J. 1842 das einzige Exemplar eines Fossiles der oberen Kohlenformation, das man auf die Fieder einer Cycadee zurückführen kann und daher wohl der Veröffentlichung werth.

Zamites BRONGN. ex parte.

Fronde pinnatae, foliolis subremotis subdistichis oblongis vel oblongo-linearibus vel linearibus obliquis basi rotundata vel auriculata rhachidi adnatis, nervis aequalibus parallelis.

Wenige von den hieher gerechneten Arten ähneln den *Zamia*-Arten der Jetztwelt, vielleicht bestätigen glückliche Funde, wie diess bei den Arten von *Pterophyllum* durch DICON. geschah, unsere Classifications-Versuche. Bereits hat schon wieder Neuholand eine Cycadee, die *Bowenia*, geliefert, welche sich durch doppeltfiederspaltige, mit anastomosirenden Nerven versehene Blätter auszeichnet, welche man lange Zeit für eine Aroidee hielt und mit dem Namen *Dracontium polyphyllum* bezeichnete. Ein ähnliches Geschick erfuhr die *Stangeria paradoxa*, die lange für ein Farnkraut galt, bis sich endlich ihre Cycadeennatur enthüllte.

Zamites arcticus m. Tab. II, Fig. 9 et 10.

Z. fronde pinnata, rhachi subflexuosa, foliolis approximatis suboppositis patentissimis linearibus obtuso-truncatis basi utrinque rotundatis, nervis parallelis parum distinctis.

Auf Schieferen der Miocänformation in Grönland bei Kook in 70° n. Br., zugleich mit *Pecopteris borealis*, *Sequoia Langsdorfi*, mitgetheilt 1848 von Herrn Dr. RINK, jetzigem Gouverneur von Grönland, wie auch noch mit vielen anderen Tertiärpflanzen und Coniferen, welche ich von Herrn FORCHHAMMER erhielt, die ich bald zu beschreiben gedenke.

Nur in einem Exemplare mit dem Gegendruck desselben vorhanden und hier in natürlicher Grösse Tab. II, Fig. 9 abgebildet. Die unterhalb und oberhalb unvollständige Fieder von 2½ Zoll Länge. Die Spindel nur schwach gebogen, wenig erhaben rundlich. Die Fiederblättchen so dicht als möglich aneinandergedrängt, hie und da gegenüberstehend, ursprünglich wohl

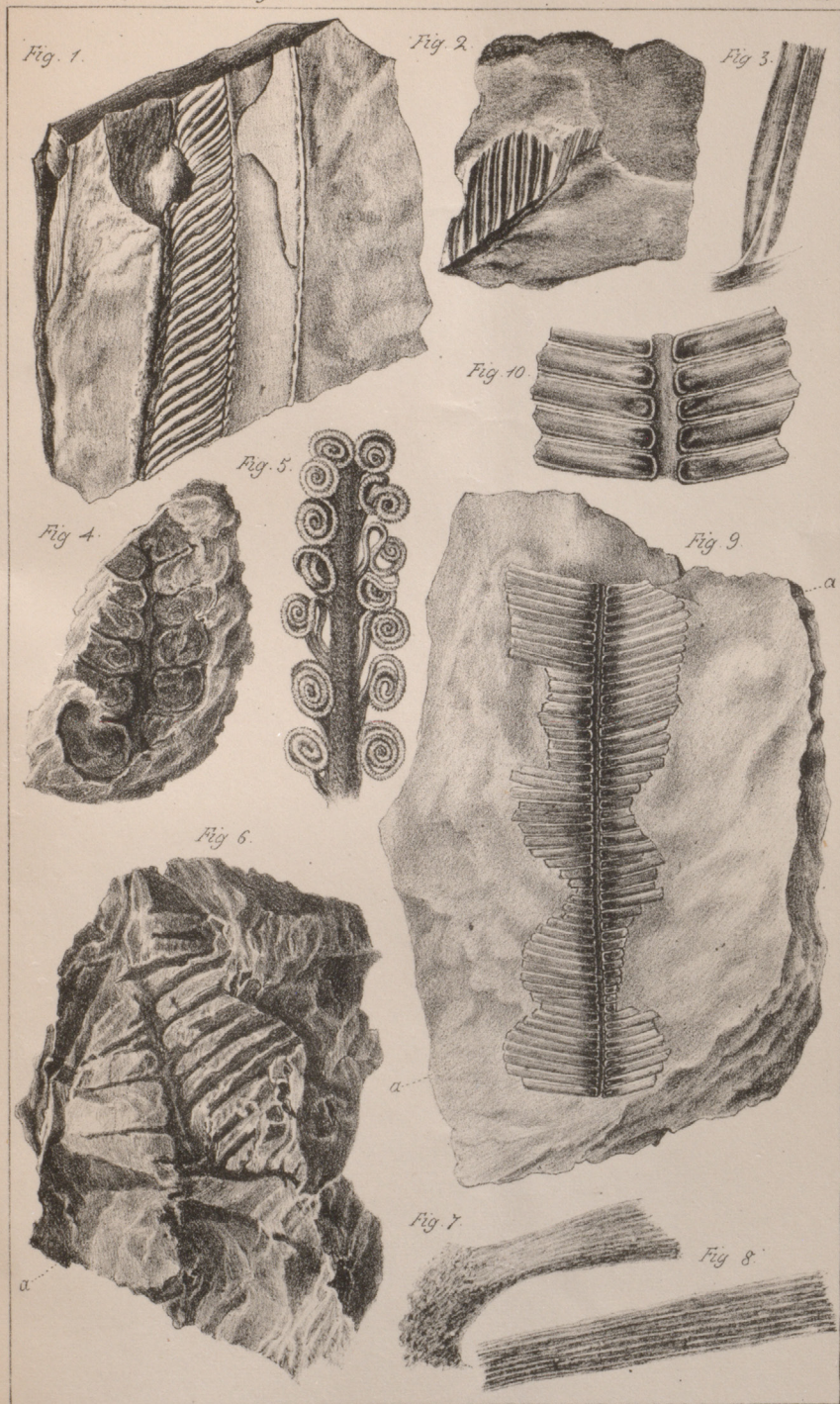
alternirend, in rechtem Winkel abstehend, nur oberhalb und unterhalb bei a vollständig erhalten $\frac{1}{3}$ Z. lang, vollkommen linear gerade mit stumpfen, ja abgeschnittenen Spitzen, an der Basis abgerundet, wohl nur mit der Mitte an der Spindel befestiget, mit einem knötchenförmigen Eindrucke, dessen Ursache und Bedeutung mir nicht recht klar erscheint. Die Nerven parallel, aber schwer zu erkennen, wie sie auch bei der Vergrößerung Fig. 10 nur wenig hervortreten.

Unsere Art steht sehr isolirt in der Reihe von *Zamites*, mehr ähnelt sie manchen Pterophyllen, wie *Pt. pecten*, wohin sie aber wegen Insertionsform der Blättchen nicht gehören kann.

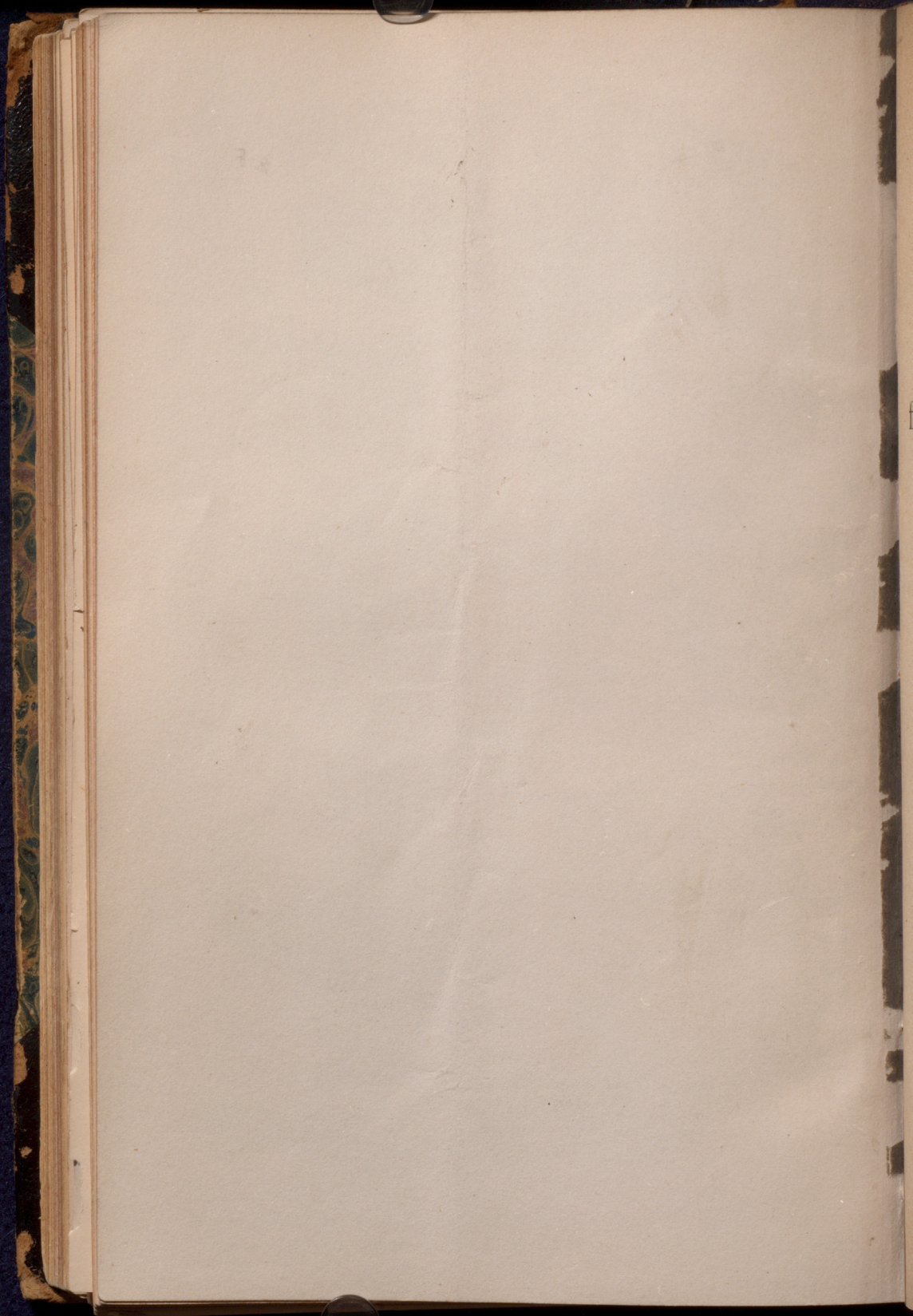
An diese Pflanze knüpft sich ein hohes paläontologisches Interesse. Abgesehen davon, dass sie, wie ich schon im Jahre 1861 bemerkte, (über die Tertiärflora der Polargegenden, Abh. der schles. Gesellsch. f. vaterl. Cultur 1861, Hft. 1, p. 194—207), mit beweist, dass jene jetzt so unwirthlichen Gegenden zur Zeit der Miocän-Periode sich eines milderen Klima's, etwa einer mittleren Temperatur von 8—10° zu erfreuen hatten, gehört sie, wie alle anderen in älteren Formationen vorkommenden *Zamites*-Arten zu einem Typus, für den bis jetzt analoge Formen fehlen.

Die Gattung *Zamites* steht in dieser Beziehung einzig in ihrer Art da, da bei allen anderen Ordnungen fossiler Pflanzen schon mit der Trias der eigenthümliche, unserer Flora fremde Typus verschwindet, bei *Zamites* aber in der Jura-Kreide und Tertiär-Gruppe erhalten bleibt.

Breslau, den 9. Dec. 1865.



1-3. *Cycadites taxodinus* GÖ, 4. *Cycadites gyrosus* GÖ, 5. *Cycas revoluta*, 6-8. *Pterophyllum nodosum* GÖ, 9-10. *Lamites arcticus* GÖpr.



Ueber die

fossile Kreideflora und ihre Leitpflanzen.

Von

Herrn H. R. Göppert in Breslau.

(Abdruck a. d. Zeitschrift d. deutschen geolog. Gesellschaft Jahrg. 1865.)

Obschon noch mit der Herausgabe eines Zweiges der älteren fossilen Flora beschäftigt, veranlasst mich doch die Entdeckung eines Farnstammes von einer noch nie beobachteten Vollständigkeit in der turonischen Kreide bei Oppeln, auf die Pflanzen zurückzukommen, welche ich auch aus der gesamten Kreideformation, besitze und wiewohl grösstentheils schon abgebildet, bis jetzt aus Mangel an Zeit immer noch nicht veröffentlichen konnte. Meine erste Arbeit über die Pflanzen der Kreide, über die des Quadersandsteins, lieferte ich im Jahre 1841 im 19. Bande der Verhandlungen der Leopoldinischen Akademie (N. Acta A. C. N. C. XIX. 2. p. 117—120); sie enthielt unter andern Fucoiden, Blattabdrücke aus Kieslingswalde in der Grafschaft Glatz, Coniferen, die so seltene Frucht einer *Dammarites* und einen sehr merkwürdigen Farnstamm *Caulopteris Singeri* aus dem oberen Quader von Giersdorf bei Bunzlau. Ein Nachtrag zu dieser Schrift erschien 1848 ebendasselbst im 22. Bd. I. p. 364, begleitet von einer Zusammenstellung aller bis dahin überhaupt bekannter Kreide-Pflanzen, deren Zahl sich damals auf etwa 80 Arten belief. Gegenwärtig beträgt sie wohl das fünffache in Folge vieler Entdeckungen in Schlesien*), dann von VON DER MARK in Westphalen, GLOCKER in Mähren, OTTO und GEINITZ in Sachsen, EICHWALD in Russland, DUNKER, STIEHLER in Blankenburg, REUSS und CORDA in Böhmen und besonders DEBEY und ETtingshausen in der Flora von Aachen, deren erste Anfänge auch von mir zugleich mit oben genannten im Jahre 1841 beschrieben wurden.

*) Besonders interessante Sachen erhielt ich von den Herren Lehrer DRESLER von Löwenberg, von Dr. ADLER und Lehrer LIMPKE von Bunzlau, Apöthecken-Besitzer HULWA, KOCH und Direktor MARTINI aus der Kreide von Oppeln, den Mineralogen KLOCKE und PECK, Conservator des naturhistorischen Museums in Görlitz. Allen Versicherungen ergebensten Dankes.

Im Allgemeinen stellt sich aus ihrer Betrachtung heraus, dass die einzelnen Floren dieser Fundorte zwar von einander wohl abweichen, wie z. B. die von Aachen und Blankenburg im Gegensatz zu den übrigen, es aber doch nicht an Anknüpfungspunkten zwischen ihnen fehlt, ja sich selbst gewisse typische Formen unter ihnen erkennen lassen, die zum Theil schon jetzt als Leitpflanzen dienen können. Ich will versuchen dies nachzuweisen und hieran noch verschiedene Bemerkungen knüpfen.

Die verbreitetste, aber freilich immer noch zur Zeit sehr angezweifelte Pflanze ist eine Alge, der *Cylindrites spongioides* m., der schon im vorigen Jahrhundert von SCHULZE abgebildet und von ihm mit Seesternen verglichen ward (dessen Betrachtung der versteinten Seesterne. Warschau, Dresden. 1760 p. 40 u. f. Taf. II. u. Taf. III.). GEINITZ beschrieb und bildete ihn ebenfalls ab, glaubte ihn aber zu den Spongien rechnen zu müssen. Ich suchte diese Ansicht zu widerlegen; aber andere (vielleicht zum Theil in Folge dieses bestrittenen Verhältnisses; denn näher untersucht hat es noch keiner) stellten wohl ganz und gar seine organische Natur in Frage und rechneten ihn zu den zufälligen Bildungen.

Unsere genannte Alge durchsetzt das Gestein mit ihren röhrenförmigen, 6-bis 8 Linien dicken, cylindrischen, oft 1 bis 2 Fuss in gleichem Durchmesser fortlaufenden Verzweigungen, die sich auf ihrer ungleich grubigen Oberfläche von dem benachbarten, meist sehr weissen Gesteine durch eine bräunlich-graue, oft auch schmutziggrünliche Farbe unterscheiden.

Dieser Wechsel von kleinen Erhöhungen und Vertiefungen, wodurch die grubige, ungleiche Oberfläche bedingt wird, ist jedoch nicht so unregelmässig, wie man beim ersten Anblick namentlich weniger gut erhaltener Exemplare schliessen möchte. Deutlich erkennt man eine quincunciale Stellung dieser Erhöhungen, wie ich auch schon bei der ersten Beschreibung und Abbildung dieser merkwürdigen Gebilde andeutete, jetzt aber mit der grössten Bestimmtheit wiederholen kann.

In ihrem Verlaufe schwellen die Zweige hier und da zu länglichen, den Durchmesser der Röhre überhaupt etwa zweibis dreimal übertreffenden Knollen an. Manchmal endigen sich

die Zweige in solche längliche Knollen, oft setzen sie sich aber auch gewissermaassen sprossend noch eine kurze Strecke fort und werden zuletzt allmählig schwächer durch Abgabe seitlicher, fast rechtwinklig abgehender Aeste. Uebrigens gelang es mir in neuerer Zeit, im Querschnitt eines grösseren Exemplars eine ringförmige, braungefärbte Schicht zu beobachten, woraus man auf eine concentrische Anordnung der Zellen schliessen kann, wie sie neuere Untersuchungen in grossen, ja wahrhaft riesigen Algenstämmen der jetzt lebenden *Macrocystis*, *Laminaria*, *Lessonia*, *Ecklonia* nachgewiesen haben. Deutlich bemerkten hier LA PYLAIE, KÜTZING, RUPPRECHT (dessen Bemerkungen über den Bau und das Wachsthum grosser Algenstämmen. *Mém. de l'Acad. impér. des sciences* T. VI. Petersb. 1848) und ich selbst bei *Laminaria* und *Ecklonia* 1 bis 8 concentrische Schichten, die eben durch Zellgewebe verschiedener Grösse und Beschaffenheit gebildet werden. Bei Ausfüllungen fossiler Gewächse bleibt nach meinen Beobachtungen an solchen Stellen, wenn auch wirklich keine Zellen oder Gefässe durch das ausfüllende Material erhalten worden, dennoch ein verschieden gefärbter Absatz gleichsam als Andeutung der früheren an dieser Stelle einst vorhandenen Organisation zurück. Auf diese Weise erkennen wir in den Ausfüllungen der Stigmarien, Sigillarien, Lepidodendreen, Cycadeen der Steinkohlenformation noch die einstige Anwesenheit der Achsen oder Centralgefässbündel, wie man insbesondere in Querschliffen solcher ausgefüllter Räume leicht erkennen kann.

Für diese Beobachtungen liefern die von GEINITZ in seiner Charakt. d. Schichten d. böhm.-sächs. Kreideg. p. 96 beschriebenen und Taf. 23 Fig. 1 sehr treu abgebildeten Exemplare meiner Meinung nach den entschiedensten Beweis. Auf diesen sitzt nämlich in der Mitte wie ein Kiel ein sogenannter kleinerer Spongit von demselben Längsverlauf und derselben Theilung, den man unmöglich, da er genau die Form des grösseren, ihm zur Basis dienenden nachahmt, für einen Parasiten, sondern für nichts weiteres als den achsenartigen inneren Theil des Stammes selbst halten kann, der, nach Verrottung der zwischen der Rinde und dem Innern befindlichen Zellenschicht, hervortrat und auf der Aussenseite zum Vorschein kam. Diese excentrische Lage der meist in der Mitte befindlichen Achse beobachtete ich unter andern bei einem $1\frac{1}{2}$ Fuss dicken Lepidodendron zu Dombrowa im Kra-

kauschen, ganz besonders häufig auch bei Stigmarien, wo die Achse oft in $1\frac{1}{2}$ bis 2 Fuss Länge an der Aussenseite des Stengels wie ein scheinbar gar nicht dazu gehörender kleiner Cylinder verläuft *). Auf diese Weise erklärt sich das sonderbare Vorkommen des kleinen auf dem grossen Exemplare ganz ungezwungen, und man hat nicht nöthig anzunehmen, dass sich ein junges Individuum auf einem älteren fortgebildet habe.

Was nun endlich noch die oben erwähnten, für die Algen- oder Fucoiden-Natur ganz besonders sprechenden, knolligen Auftreibungen der Stengel betrifft, so verdanken sie gewiss nicht zufälligen Anhäufungen einer grössern Menge des Schwammgewebes ihren Ursprung, wie mein Freund GEINITZ meint, sondern gehören mit zu der Organisation, indem sie innerhalb höchst wahrscheinlich wie die ähnlich gestalteten Luftbehälter der oben genannten Fucus-Arten hohl waren und so einer bestimmten Function vorstanden. Der Mangel an kohliger Substanz spricht endlich auch nicht gegen den vegetabilischen Ursprung unsers Fossils, indem diese sehr häufig bei Algen fehlt, ja auch selbst bei Landpflanzen unserer Formation vermisst wird. Offenbar waren diese Pflanzen auch noch lange nach der Fossilisation der Inundation ausgesetzt, wodurch die vegetabilische Substanz durch Verwesung zerstört wurde, sodass nur noch der Abdruck die einstige organische Form anzeigt. Durch comparative Abbildungen werde ich diese Ansichten in meiner Arbeit noch weiter zu begründen suchen, inzwischen wünschte ich nur, dass man zunächst aufhören möge, unsre Alge in das vage Gebiet der zufälligen Bildungen zu versetzen, da sie überdies auch wegen der sehr in die Augen fallenden Form und grossen Verbreitung für die Geognosten von grosser Bedeutung erscheint.

Zunächst dient sie, wie schon GEINITZ sehr richtig bemerkt, dazu, die Sandsteine der Kreideformation von allen andern im Aeussern und in Lagerungsverhältnissen

*) Wenn man jetztlebende Pflanzen, die in der Mitte ein achsenartiges Organ besitzen, wie Stengel von Equisetum oder Myriophyllum faulen lässt, wird die Achse weit später als das zwischen ihr und der Rinde des Stammes befindliche Zellgewebe zerstört. Sie flottirt dann haltlos hin und her und legt sich an die Rinde, wobei natürlich ihre centrische Lage verloren geht. Ein recht anschauliches Bild des auf gleicher Ursache beruhenden Vorganges in der Vorwelt.

ähnlichen Sandsteinen der Tertiärformation zu unterscheiden. Weniger ist sie zur Unterscheidung der einzelnen Schichten der ersteren geeignet, weil sie in allen drei Hauptabtheilungen derselben angetroffen wird. In Schlesien fand ich sie in den zum oberen Quadersandstein (oberen Quadermergel nach GEINITZ) gehörenden kalkigen Mergeln und Grünsandsteinen von Kieslingswalde mit *Callianassa antiqua* OTTO und mit vielen Dicotyledonenblättern, ferner auf dem Krähenberge bei Langenau, zwischen Habelschwerdt und Eisersdorf, bei Altwaltersdorf und Melling, in dem vielleicht zum untern Quader gehörenden Steinbruch am rechten Ufer der Neisse bei Habelschwerdt, im böhmisch-schlesischen Grenzgebirge bei Braunau, so wie um Bunzlau und Löwenberg. Aus Regensburg in ähnlicher Formation sah ich sie in der Sammlung des Grafen MÜNSTER. GEINITZ fand sie daselbst ebenfalls, desgleichen in Böhmen, in dem sächsisch-böhmischen Grenzgebirge, in Sachsen an sehr vielen Stellen sowohl im oberen Quadersandstein bei Schandau (cf. GEINITZ, das Quadergebirge oder die Kreideformation in Sachsen. 1850. S. 3) und andern Sandsteinbrüchen an der Elbe, also in den verschiedenen Schichten des Quadermergels und des untern Quadersandsteins (Ebendas. S. 24, 30, 32, 33, 35).

Noch häufiger traf ich sie bei Ibbenbüren in den Sandsteinbrüchen der Drenther Berge zugleich mit einer andern Alge, *Sphaerococcites lichenoides*, dann im Münsterlande in den kieselreichen Quadersandsteinknollen zwischen Coesfeld und Horstmar. So fest sie hier erschienen, so zersetzt finden wir sie, aber doch noch leicht erkennbar, in den hangenden Sandsteinschichten der Steinkohlengruben der Umgegend von Essen.

Neuerdings habe ich sie auch von Blankenburg durch Herrn HAMPE erhalten.

Unter den zahlreichen, insbesondere bei Aachen beobachteten Farn, sind zwar viele sehr interessante Formen, aber doch keine baumartigen, deren Vorkommen sich bisher auf Schlesien und Böhmen beschränkte, worüber ich jüngst eine kleine Abhandlung veröffentlichte (Ueber das Vorkommen der Baumfarn und der fossilen Flora insbesondere in der Kreideformation; in G. LEONH. u. GEINITZ' N. Jahrb. 4 Heft 1865

p. 394—399). Ich zeigte darin, dass die früher von mir unter dem Namen *Caulopteris Singeri* aus dem Quadersandstein von Giersdorf bei Löwenberg in Schlesien beschriebene Art mit der böhmischen, nicht aus der Kohlen-, sondern aus der oberen Quaderformation stammenden *Caulopteris punctata* STERNB. und diese von CORDA zu *Protopteris* gebrachte Art wieder mit *Protopteris Cottae* identisch sei.

Ein dritter Fundort tritt nun noch hinzu, nämlich Shaftesbury in Dorsetshire (WILLIAM CARRUTHERS, on *Caulopteris punctata* GÖPP., a treefern from the upper Greensand of Shaftesbury in Dorsetshire; in the *Geological Magazine* etc. edited by HENRY WOODWARD. Novbr. 1865 p. 484—487 Tab. XIII.). CARRUTHER, der meine Abhandlung nicht gekannt zu haben scheint, ist zu gleichen Ansichten wie ich hinsichtlich der Identität der genannten Arten gelangt.

Von Monokotyledonen fand ich bis jetzt nur eine manchen Palmen ähnliche Blattpflanze, welche mit der von MIQUEL abgebildeten Taf. I. Fig. 3 genau übereinkommt. Sie stammt aus den Kalkschichten bei Schulter, die von ihm aber nur fraglich zum senonischen System gezogen werden.

In der kalkführenden Sandsteinformation zwischen Kwasitz und Kremsier fand E. GLOCKER zugleich mit einer Alge, *Keckia annulata*, einst eine höchst räthselhafte, an die Rotularien und Annularien der paläozoischen Landflorenerinnernde, höchst wahrscheinlich dicotyledone Pflanze, mit ungegliedertem Stengel und länglichen, ganzrandigen, nervenlosen Blättchen, welche, wie die Abbildung zeigt (Nov. Acta Vol. XIX. Suppl. II. p. 322) einen zehnbältrigen Quirl bilden. Er nannte sie *Gyrophyllites quassazensis*. Diese fast ganz vergessene Pflanze ward von HEER, der aber GLOCKER als Autor der Gattung dabei nicht erwähnt, im Neocomien des Kanton Freiburg bei Chatel St. Denis in 4 Arten beobachtet, von denen die eine der Abbildung und Beschreibung nach (Vorwelt der Schweiz 1. Bd. S. 190) ganz mit der GLOCKER'schen übereinstimmt und daher statt *G. obtusifolius*, *G. quassazensis* GLOCKER zu nennen ist.

Aus der Reihe der Coniferen begegnen wir zunächst einem Stammbruchstück, *Pinites ucranicus* m. (GÖPP. fossile Coniferen p. 201 Taf. 26 Fig. 1—4) aus der oberen Kreide bei Charkow in Russland, durchbohrt von *Teredo* und *Fistulana*, welche BREA in den oberen Schichten des St. Petersberges (Syst. Mastrichien) fand und MIQUEL a. a. O. p. 13 Tab. IX. abbildete.

Von der weitesten Verbreitung tritt *Geinitzia cretacea* ENDL. in allen drei Schichten der Senongruppe auf: in Schlesien in der Kreide bei Oppeln, Kieslingswalde, Ullersdorf, bei Naumburg am Queis, Bunzlau, Wenig Rackwitz; in Böhmen im Grünsand von Baun, im sandigen Pläner bei Hradek, Perutz, Trzibitz und Smolnitz, im kalkhaltigen Pläner bei Hundorf und Kutschlin; in Sachsen im unteren Quader bei Bannewitz, im Pläner bei Goppeln, im Kalkpläner bei Strehla und im Thon des Quadersandsteines bei Waltersdorf, im Plänersandstein von Rippien bei Dresden und dem unteren Quadersandstein von Melschhuf bei Dresden. Endlich auch zu Kurs bei Charkow in Russland.

Cunninghamites Oxycedrus PRESL.; zuerst gefunden im Grünsand bei Schöna in Sachsen, dann bei Blankenburg (als *Abietites Goeppertii*, *Linkii* und *Hartigii* von DUNKER beschrieben und abgebildet in MEYER u. DUNKER, Palaeontogr. 4. Bd. p. 179 Taf. 32 u. 33 Fig. 1 u. 2); in Schlesien in zum Ueberquader gehörendem Schieferthon zu Wenig Rackwitz bei Löwenberg mit *Geinitzia cretacea*; in Böhmen im Unterquader bei Perutz (als *Cunninghamites planifolius* ENDL.) und zu Maseno bei Schlau (C. *elegans* ENDL.); im Kreidemergel bei Lemberg in Galizien (als *Bergeria minuta* KNER). Alle diese als besondere Arten unterschiedenen Formen gehören unstreitig sämtlich zu *Oxycedrus*.

Die bisher in ihrem Vorkommen nur auf die Gegend von Blankenburg beschränkten Crednerien sind nun auch jüngst von Herrn Dr. ADLER im cenomanen Sandstein bei Neuwartha bei Bunzlau aufgefunden worden. Da inzwischen der Rand des Blattes fehlt, lässt sich die Art selbst nicht bestimmen.

Hoffentlich gelingt es bald vollständigere Exemplare zu erhalten.

Die in Kieslingswalde vorkommenden Dicotyledonenblätter, einst wahrscheinlich von sehr fester, fast lederartiger Consistenz, ähneln immergrünen exotischen Eichen, auch wohl Weiden und Ericineen, einige selbst Blättern mancher tertiärer Lager, ohne aber mit ihnen übereinzustimmen, was mich denn auch veranlasste, sie früher mit Angabe ihrer Verwandtschaft nur unter dem bekannten Sammelnamen *Phyllites* zu beschreiben. Neuholländische Formen, ähnlich den Proteaceen, welche ETTINGSHAUSEN und DEBEY in Aachen fanden, sind unter ihnen bis jetzt noch nicht vorgekommen. Hinsichtlich des einen besonders charakteristischen Blattes (*Phyllites Geinitzianus* m.), welches auffallend an die sehr verbreiteten Eichen der Tertiärformation *Quercus furcinervis* und *Q. Castanea* erinnert, ward meine Vorsicht bald gerechtfertigt, indem MIQUEL nach einem Funde von BOSQUET in von ihnen zum *Système Mastrichien* gerechneten Kalkschichten zeigte, dass diese einzelnen Blätter Theile eines gedrehten Blattes seien. Er vergleicht sie mit Artocarpeen, nennt sie *Debeya serrata* unter Hinzufügung folgender Diagnose: *folia ternata, foliola brevissime petiolata, medium paulo majus e basi rotundata subobverse lanceolato-oblonga, apice obtusiuscula coriacea inaequaliter serrata, costulis patentibus* (*De fossiele Planten van het Krijt in het hertogdom Limburg. Haarlem. A. C. KRUSEMANN. 1853 p. 6 t. 1 f. 1; vergleiche auch DEBEY, Beitrag zur Flora der holländischen Kreide. 1851. Bd. 8 S. 56.*).

In Kieslingswalde hatte ich bis jetzt nur einzelne Blätter gefunden; zu drei verbunden erhielt ich sie zuerst aus Ullersdorf von Herrn Lehrer DRESLER in Löwenberg und von Bunzlau durch Herrn Dr. ADLER, die ich sämmtlich wegen ihrer grösseren Vollständigkeit abbilden werde. Unter andern geben sie Aufschluss über die den MIQUEL'schen Exemplaren fehlenden Spitzen der Blätter, welche verschmälert und bis in ihr oberstes Ende mit Sägezähnen besetzt erscheinen. Wenn ich nicht irre, so gehört dies Blatt mit dem *Himantites Alopecurus* von DEBEY und ETTINGSHAUSEN (l. c. T. III. p. 1) ebenfalls zu *Debeya*, ein interessantes Vorkommen, da es die einzige Pflanze

ist, welche unsere Quaderformation mit der Aachener gemeinschaftlich besitzt.

Ein anderes Blatt MIQUEL's a. a. O. p. 9 Tab. I. Fig. 2, *Phyllites laevigatus*, aus dem Fundorte des vorigen, kommt in der Oberlausitz vor und ward von mir a. a. O. ebenfalls abgebildet Tab. LIII. Fig. 9, 10; desgleichen MIQUEL's *Delesserites Thierensis* a. a. O. Tab. I. Fig. 4 aus den Kieselkalkschichten des St. Petersberger *Système Sénonien*. Zu *Phyllites laevigatus* gehören unstreitig noch einige Blätter bei E. v. OTTO (dessen Additamenta zur Flora des Quadergebirges in Sachsen II. Heft. 1854. Tab. IX. Fig. 1—7) und von CORDA (in REUSS, Verstein. der böhmischen Kreideformation II. Tab. I. Fig. 9 aus dem cenomanen Sandstein von Trzibitz).

Schliesslich folgt noch eine Zusammenstellung der hier erwähnten, mehr oder weniger weit verbreiteten Arten, welche ich bereits unter dem 31. März 1865 in der Leopoldina, der Zeitschrift der Leopoldinischen Akademie, auszugslich mittheilte:

Pflanzen:	Néocomien		Céno-manien		Sénouien	
	Neocom-Gruppe.		Cenoman-Gruppe.		Turon-Gruppe.	Senon-Gruppe.
<i>Cylindrites spongioides</i> m.	Dreuthie Berge bei Ibbenbüren mit <i>Sphaerococcolithenoides</i> und Blattfiederresten von Palmen.		Esen, Braunan, Schandau, Regensburg Calabrien, Pisa, Habelschwerdt (unfern der Neissebrücke) in Schlesien.			Zwischen Coesfeld und Horstmar, Kieslingswalde, Blankenburg.
<i>Protopteris Sternbergii</i> CORDA			Kamnitz in Böhmen, Grünsand in Shaftesbury in Dorsetshire.			Oppeln, Giersdorf in Niederschlesien (Abtheilung des oberen Quadersandsteins nach BEYRICH).
<i>Debeya serrata</i> MIQUEL (<i>Phyllites Geinitzianus</i> m.)						Mastricht, Aachen, Kieslingswalde, Ullersdorf b. Naumburg a. Queiss (oberer Quadersandstein nach BEYRICH), desgleichen Kurs in Russland.
<i>Phyllites laevigatus</i> MIQUEL.			Tiefenfurt in der Lausitz, Trzibitz in Böhmen.			Mastricht, Kieslingswalde, Grafschaft Glatz.
<i>Gyrophyllites quassanzensis</i> GLOCK.	Chatel St. Denis bei Freiburg in der Schweiz.		Marchsandstein nach GLOCKER.			
<i>Delesserites Thierensis</i> MIQUEL.			Trzibitz in Böhmen.			Mastricht, Kieslingswalde.
<i>Cunninghamites Oxycedrus</i> FRESL.			Perutz und Maseno in Böhmen, Lemberg in Galizien.		Schöna.	Blankenburg, Wenig-Rackwitz, Oppeln.
<i>Geinitzia cretacea</i> ENDL.			Sachsen, Böhmen.		Oppeln.	Mastricht In den untersten Schichten bei Neu-Wartha (BEYRICH, DRESLER), in den oberen bei Ullersdorf (ADLER, DRESLER, KLOCKE) in den obersten dem Ueberquader, in dem Schieferthon der Kohlenlager bei Wenig-Rackwitz nach eigenen Beobachtungen; endlich auch im Plattenkalk der jüngsten Kreide Westphalens bei Sendenhorst von v. D. MARK als <i>Araucarites adpressus</i> beschrieben und abgebildet, aber unbedenklich mit Geinitzia zu vereinen.
<i>Pinites ucranicus</i> m.			Charkow.			Mastricht.

Aus diesen ersten Anfängen der Parallelisirung der Pflanzen der Kreideformation ergibt sich, dass unter ihnen schon mehrere in zwei, ja selbst in drei durch ihr geognostisches Alter verschiedenen Gruppen vorkommen, und zwar in zwei: *Protopteris Sternbergii*, *Phyllites laevigatus*, *Gyrophyllites quassazensis*, *Delesserites Thierensis*, *Pinites ucranicus*; in drei verschiedenen Schichten: *Geinitzia cretacea* und *Cylindrites spongioides*, welche letztere sogar bis zum Néocomien hinabreicht, eine Ausdehnung der Verbreitung, wie sie in allen grossen Formationsgruppen vorkommt und auch in der Kreideperiode für die thierischen Petrefakten bereits von EWALD (Zeitschrift der deutschen geolog. Gesellschaft Bd. VII. S. 7) und R. DRESCHER (ebendas. Bd. XV. S. 323) nachgewiesen worden ist.

Was nun insbesondere Schlesien anbetrifft, so dürfen wir ungeachtet des sehr sparsamen Vorkommens von Exemplaren doch wohl noch mehr Ausbeute insbesondere in den zum Ueberquader gerechneten Schichten der Umgegend von Löwenberg entgegentreten. Jüngst noch fand ich unter mir von Herrn DRESCHER gütigst mitgetheilten Schiefern eine trefflich erhaltene, mit Sporangien versehene *Gleichenia*, *Gl. Dresleriana* m., dann ein *Cannophyllites* und endlich noch einen neuen Farnstamm. Ein weiter Rahmen für unsere subtropische Flora, dessen baldige Ausfüllung wir wünschen.

Sur la Structure de la Houille.

Commentaire

des Photographies et des Exemplaires

que fait figurer à l'Exposition Universelle de Paris

M. le Professeur Dr. Goeppert,

Directeur du Jardin Botanique Royal de Breslau.

Il y a longtemps que l'on s'est occupé de cette question: Quelle est l'origine, quelle est la composition de la houille?

Le fondateur de la minéralogie, comme science, Agricola (1544) crut pouvoir expliquer la formation de la houille par la solidification d'une poix minérale liquide. — Naguère encore, bien que par erreur, on a donné une certaine valeur à cette théorie, en tant que l'on a admis qu'il n'était plus possible de reconnaître dans la houille une structure organique déterminée, car on n'a point jugé dignes d'une attention particulière les restes de plantes qui s'y trouvent en si grande quantité.

Mais lorsque, plus tard, on examina scrupuleusement ces détritux végétaux, on se vit bientôt amené à reconnaître en eux la participation la plus essentielle à la formation de la houille.

Au commencement de ce siècle déjà, Schlotheim émit cette opinion, à laquelle, vingt ans après, vinrent se rattacher les savants fondateurs de la Flora fossile: le comte C. de Sternberg et M. Adolphe Brongniart. Développant les recherches commencées par Schlotheim sur la nature de ces plantes, ils en vinrent à une conclusion systématique.

Comme formes principales on reconnut d'abord: les Sigillaires, nom que leur donna M. Adolphe Brongniart, à cause de leurs cicatrices foliaires, sur des troncs sillonnés, et que l'on pourrait comparer à des cachets, avec leurs racines, les stigmariées. Par des déductions anatomiques, A. Brongniart les déclara pour telles, ainsi que Binney, Dawson, Meitzen et moi-même l'avons démontré par des exemplaires. Ensuite, les arbres conifères semblables à nos Araucariées; les Nöggerathiées avec leurs feuilles pennatifères ressemblant à des palmes; les Lepidodendrées (Lepidodendron et Sagenaria à côté de l'Ulodendron et du Megaphyton y appartenants), ce sont des arbres squammeux, des Lycopodiacées arborescentes où l'on voit de jolies cicatrices foliaires squammeuses. On remarque encore les Calamites (Calamariées), équisétacées arborescentes avec quelques autres familles parentes, mais peu répandues; enfin des fougères, ressemblant à nos fougères tropiques; il en est d'arborescentes, bien que celles-ci ne se voient pas en si grande quantité qu'on s'est cru d'ordinaire fondé à le croire. — On ne saurait contester la solitude, le triste caractère que devaient offrir les forêts formées par cette végétation. Elles étaient dépourvues de l'immense ornement qu'y donne la variété du feuillage, de la floraison, tout comme de la diversité du monde animal. Ces solitudes n'étaient guère peuplées que d'un petit nombre d'insectes et de rares amphibiés. Leur plus haute importance leur vient pourtant de leur croissance en massifs bien groupés et du rôle que leur a dévolu l'histoire de la période la plus avancée, quand elles ont été étudiées transformées en houille.

Quant à la part quantitative que chacun des genres végétaux a pris à la formation de la houille, on n'a pu naturellement la déterminer qu'après avoir pris en considération, non seulement les plantes contenues dans les schistes et les grès, comme jusqu'alors, mais aussi celles contenues dans le charbon même. Remarquons ici qu'on s'était accoutumé, il y a trente ans encore, à considérer la houille comme sans structure.

C'est à l'année 1844 que remontent mes premières explorations dans les houillères des districts de Nicolaï et de Mys

lowitz (Haute-Silésie). On extrayait alors de ces mines près de vingt millions de quintaux de houille.

Je pus alors constater, comme jamais encore je ne l'avais fait, un tel état de conservation dans les plantes qui avaient servi à la formation du charbon, que chaque fragment, pour ainsi dire, offrait l'aspect d'un herbier antediluvien. — Le charme était donc brisé; je continuai de trouver, sinon à un degré aussi éminent, des particularités analogues dans d'autres mines de la Haute-Silésie. Il en fut de même dans la Basse-Silésie et, plus tard aussi, dans les districts de Westphalie, d'Aix-la-Chapelle et de Saarbrück, que je parcourus de mine en mine pendant les vacances de cinq années consécutives. — Enfin, je parvins à démontrer qu'au moyen du microscope, on pouvait encore reconnaître, dans la cendre du charbon, et après leur formation par le silex ou la chaux (le calcaire), les squelettes des cellules et des vaisseaux des végétaux. Comme donnée principale, il résulte que la matière première de la houille ne consiste pas, comme on l'avait cru jusqu'alors, dans les fougères, mais dans les Sigillaires, mélangées aux Stigmariées qui sont de la même famille, puis dans les conifères, surtout les Araucariées, combinées avec les Calamites et les Nöggerathiées, représentantes des palmes dans la formation de la houille. Alors seulement viennent les Lepidodendrées, les fougères et les autres groupes de végétaux qu'on y a découverts naguère, mais en moins grande quantité: (Calamodendron, Annulariées, Sphenophyllées etc.). Personne encore n'y a pu établir avec certitude la présence de plantes marines, que quelques-uns y supposaient jadis.

Les troncs des Sigillaires, des Lepidodendrées et des Calamariées ne sont rien moins que très-fermes; ils sont parenchymateux, du reste, et la matière ligneuse n'y entre guère que pour un sixième de leur diamètre. Ils furent jadis submergés, amollis, comprimés par des couches de sable et d'argile, après quoi l'intérieur, exprimé par voie humide, s'est, comme l'écorce, transformé en charbon. Cependant les bois des Conifères (Araucariées) plus fermes et par là-même n'ayant pas atteint le même degré de décomposition, s'y trouvent en quantité, répandus par fragments dans la masse.

On rencontre des couches de feuilles de Nöggerathiées entremêlées de fruits et de semences. Dans la formation de la houille, on ne saurait assez apprécier la coopération de la compression, puisqu'une si grande partie, peut-être même la masse principale des charbons, n'a pas été formée absolument par les cellules et les vaisseaux ligneux, mais par les tissus parenchymateux. — Le chimiste qui prendrait en sérieuse considération ces faits *), que, depuis longtemps, j'ai publiés, verrait s'ouvrir un nouveau champ d'activité, s'il voulait se résoudre à analyser une à une les plantes qu'à l'oeil nu, on distingue dans la houille. — Le procédé actuel rappelle ces méthodes, dès longtemps tombées dans l'oubli, où, pour faire une analyse organique, on commençait par mettre au pilon toute la plante, ou bien même des animaux, et que, par l'analyse de ce mélange, on croyait obtenir les résultats les plus importants.

Outre divers gisements de houille et que, dans les voyages sus-mentionnés, j'ai découverts riches en structure, c'est la Haute-Silésie surtout, et particulièrement le district de Nicolaï, qui fournit à cet effet une source inépuisable et facile à exploiter. De plus, M. Degenhardt, premier ingénieur des mines, à Orzesche est bien le guide le plus éclairé pour l'exploration de ces trésors inépuisables. — C'est ainsi, par exemple, que le chemin de fer qui va de Kattowitz à Rybnik, forme un chemin creux dont les murs, hauts de 10 pieds, sont formés, sur une longueur de plus de 500 pieds, par des Sigillaires etc., en quoi presque partout consiste le toit des couches.

*) Traité envoyé comme réponse à cette question mise au concours: Qu'on cherche à démontrer, par un examen attentif, si les gisements de houille proviennent de plantes qui se sont développées aux lieux même où on les rencontre, ou bien si ces plantes ont végété, vécu en d'autres endroits et si elles ont été portées aux lieux où se trouvent les gisements de houille? — Cet écrit remporta un prix double; Haarlem 1848. 300 p. in Quarto, 23 Tab. in folio.

Sur les gisements de houille des bords du Rhin, v. Archives etc. de v. Dechen et de Karsten, 23 Vol., I. cahier, 1849; sur ceux de Westphalie, v. le XI. volume des assemblées des naturalistes des provinces Rhénanes, puis on peut consulter encore les débats des Sociétés Silésiennes, 1851, 1852, 1863 etc.

Ai-je besoin de parler des milliers de milliers de troncs qui se trouvent érigés dressés sur les couches? Ils sont saturés d'oxyde de fer, qui sur tant et tant de milles carrés prennent une si forte part à la richesse en minerai de la Haute-Silésie, et qui, sous le rapport géologique, permettent des conclusions si importantes sur la formation de ces gîtes.

C'est ce que nous n'examinerons pas ici plus à fond; nous restreignant au but spécial de nos recherches actuelles. Ce but devait être de démontrer la présence, dans la houille, de plantes perceptibles même encore à l'oeil nu. Nous ajouterons toutefois que les résultats obtenus par nous déjà entre les années 1837 et 1850 ont été confirmés par de nombreux naturalistes de l'Allemagne, de la France, de l'Angleterre et de l'Amérique du Nord.

Passant à l'explication des photographies figurant*) ici, à Paris, je fais observer que le No. 1 représente des charbons composés uniquement d'écorces de *Sigillaires* comprimées les unes sur les autres. — Le No. 2 donne un des plus grands exemplaires de notre collection, tiré des couches supérieures d'une exploitation à ciel ouvert, sur laquelle les *Sigillaires*, particulièrement *S. cyclostigma*, gisaient entremêlés jusqu'à 20 pieds de longueur; le No. 3: la *Sigillaria elegans* Brongn., fort répandue aussi, avec les cicatrices à branches verticillées, à distances égales; le No. 4: *Sigillaria Boblayi* Br., où les cicatrices foliaires sont nettement exprimées; le No. 5: *Sigillaria alternans*, et le No. 7: *Sigillaria alternans* var. *grandis*; le No. 9: *Sigillaria maxima* m., ainsi appelée à cause de la grandeur extraordinaire des cicatrices pourvues de nombreuses feuilles de *Nöggerathiées* à côtes parallèles; le No. 6 représente la *Sigillaria elliptica*, aux cicatrices à branches verticillées; semblable au No. 10b; le No. 28 offre la *Sigillaria maxima* et la *Sigillaria catenulata* Lindl.; le No. 9: *Sigillaria micans*; le No. 29 *Sigillaria Menardi* et l'*elliptica*. Toutes

*) Nous sommes redevable des frais de toute cette exposition au haut intérêt que porte aux sciences et aux lettres le Ministère Royal du commerce, de l'industrie et des travaux publics en Prusse.

appartiennent aux espèces les plus communes que l'on trouve dans la houille du district de Nicolaï, déjà mentionné, où j'ai trouvé en outre 25 végétaux dans le charbon même et tout autant dans les ardoises qui accompagnent la houille. Voilà donc, en somme, près de 50 espèces de ce genre si multiforme. La Sigillaire appartient au petit nombre de plantes fossiles pour lesquelles nous n'avons point encore découvert d'analogie. D'après mes observations, cette plante se développait d'un tubercule arrondi, que j'ai aussi trouvé dans la houille. De ce tubercule, qui grossissait, et qui, comme d'un punctum vegetationis, parvenait à l'état de bulbe sans racine pivotante, poussaient horizontalement de nombreuses racines latérales (la *Stigmaria ficoïdes*), après quoi le tronc de la Sigillaire s'élevait verticalement.

Sous les No. 31 — 35, j'ai pris plaisir à faire figurer quelques-uns des dessins originaux de ces périodes de développement, tout comme un exemplaire original de huit pieds de long, de la *Stigmaria ficoïdes*, portant le No. 31. — Pour de plus amples explications, je renvoie à mon ouvrage sur la Flora Permienne, Cassel 1865 (Tab. 31 et 32).

Les photographies No. 11 et 12 représentent la *Stigmaria ficoïdes* dans le charbon; c'est-à-dire, le No. 11 la *Stigmaria* commune, le No. 12 la plus rare, forme que j'ai appelée *rugosa*. — Aux Sigillaires se rattachent les *Lepidodendrées*, dont particulièrement le *Lepidostrobus laricinus*, Sternb. No. 20 est fréquent. A ce dernier appartient la plante qui portait le nom de *Ulodendron majus* No. 21, forme remarquable par les cicatrices strobiliformes des branches. — Le No. 22, c'est la *Halonium tuberculata* ou *punctata*; le No. 18b, la *Sagenaria aculeata*, face extérieure de l'écorce; le No. 19, la même, avec la face intérieure de l'écorce; le No. 17, la même encore, mais à un degré de développement peu avancé, ainsi que b, avec une autre espèce de *Sagen. caelata*, et le No. 18a, la *Sagen. obovata*. Les *Calamites* ne manquent pas non plus; p. ex. le No. 24, *Calamites canaliculatus*, avec les Sigillaires qui les recouvrent, et le No. 23, *Calamodendron approximatum* Br. (*Calamites approximatus*).

A cause de la part notable qu'elles prennent à la composition de la houille, nous attacherons une importance toute

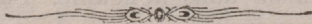
particulière aux Conifères de la Flora des houillères, vû leur analogie avec les Araucariées de notre époque. Ces conifères ne se rencontrent d'ordinaire dans le charbon qu'en petits fragments. Mais, dans les forts gisements de la Haute-Silésie, dans certaines mines, comme par exemple dans la mine de Przemza, on les trouve en bûches, longues de plusieurs pieds, et généralement dépouillées de leur écorce. — J'ai voué à ce genre une attention spéciale: le No. 15 représente des fragments à part avec des restes d'écorce; le No. 16, une bûche de plus d'un pied de long; le No. 14, un tronc large d'un pied, et enfin, le No. 13, a, b, c, les exemplaires les plus intéressants, avec des cercles concentriques, bien marqués, dans la houille passée à l'état de coak. Au microscope, on peut saisir dans α les cellules radiaires du Prosenchyme. — Le nom d'Araucarites carbonarius n'a donc naturellement qu'une signification passagère. — Des tiges de Calamodendron peuvent également s'y trouver. Le No. 26 reproduit un exemplaire rare nommé en allemand „Augen- oder Blumenkohle“, dans une perfection que, jamais encore, on n'avait vue. Cependant nous ne pouvons les considérer que comme un produit de formation anorganique, tel qu'il s'en forme dans le charbon fossile très-compacte et qui prend parfois la forme radiaire-pyramidale, ainsi que le démontre le No. 27 a et b. Le No. 25 a, b, c représente des fruits, qui ne se voient que rarement dans la houille. Selon nos recherches les plus récentes, ces fruits se rapprochent le plus des palmes (Flora Permienne p., Tab. 26 à 29): a, b, c Trigonocarpus Nöggerathii Brongn. et d. T. Schulzianus m.

Ajoutons, que toutes ces photographies représentent les originaux dans leur grandeur naturelle.

Tous les originaux font partie de ma collection particulière, qui renferme 12,000 numéros de plantes fossiles, dont plus de 1000 ont servi d'originaux à mes écrits. Nous faisons contribuer à l'illustration du contenu de ce traité les 24 fragments de charbon, qui figurent à notre exposition. Quelques-uns sont assez volumineux; beaucoup ont servi d'originaux aux photographies exposées; nous y joignons un certain nombre de Sigillaires remplies d'argile schisteuse bitumineuse.

Pour terminer, nous ferons remarquer que la production en houille du pays auquel nous devons ces fossiles, la Haute-Silésie, va toujours croissant; elle est loin d'avoir atteint son apogée. Il y a 25 ans qu'elle n'était que de 2,937,570 tonnes; en 1865, on en extrayait déjà 21,237,570 tonnes. Néanmoins, on est loin d'avoir à s'inquiéter de l'épuisement des mines, car la formation de la houille s'étend sur un territoire d'au moins 100 milles carrés, et la puissance totale de toutes les couches s'évalue en moyenne à 300 pieds. La surface actuellement en exploitation ne dépasse guère 18 à 20 milles carrés.

Si donc nous considérons que, sur la même étendue de territoire et dans cette même année 1865, on a tiré des mines environ 7,917,222 quintanx de minerai de fer et 5,372,048 de calamine, ce qui, la houille incluse, représente une valeur de neuf millions de Thalers, on peut se faire une idée de l'importance de la Silésie pour notre monarchie.



Über einige seltene Versteinerungen aus der unteren Dyas und der Steinkohlen-Formation

von

Dr. H. B. Geinitz.

(Hierzu Tafel II und III.)

1) *Ephemerites Rückerti* GEIN. — Taf. II, Fig. 1.

Herr CARL RÜCKERT in Stockheim, welcher die Steinkohlenformation von Stockheim und Neuhaus am südwestlichen Abhange des Thüringer Waldes einer eingehenden Untersuchung unterworfen hat, die in der nächsten Zeit veröffentlicht werden wird, übersandte mir neben vielen anderen in diesem Gebiete vorkommenden organischen Überresten auch das höchst interessante Fossil, das ich mit seinem Namen hier einführen will. Es wurde von ihm in dem rothen Schieferletten des unteren Rothliegenden von Reitsch unweit Stockheim entdeckt in einer ungefähr 400 Fuss über dem Steinkohlenflötze lagernden Schicht, in welcher von ihm gleichzeitig eine für die untere Dyas leitende Pflanze, *Cordailes Ottonis* GEIN., gefunden worden ist.

Das Fossil ist der Flügel eines Insekts, das unter den lebenden Arten seine nächsten Verwandten in der Gruppe der Ephemerinen oder Eintagsfliegen hat, unter den fossilen Arten aber dem von WESTWOOD, *Quat. Journ. of the Geol. Soc. London*, V. X, tb. 15, f. 5 aus den unteren Purbeck-Schichten Englands abgebildeten Flügel einer „*Dragon-fly*“ am ähnlichsten erscheint.

Von allen bisher aus der Steinkohlenformation und den un-

teren Schichten der Dyas durch GERMAR, GOLDENBERG, DANA und ANDREE beschriebenen Insekten-Resten weicht dieser wesentlich ab und er gehört jedenfalls einer neuen, noch nicht beschriebenen und wie es scheint noch nie beobachteten Art an, die man wohl am besten als *Ephemerites* bezeichnen kann. Eine genauere Diagnose für die Art wird sich freilich erst dann feststellen lassen, nachdem ein glücklicher Zufall uns über den Anfang und das Ende dieses Flügels belehrt haben wird.

Es mag vorläufig genügen, die Gattungs-Verwandtschaft des Fossils festgestellt zu haben.

Zu diesem Behufe übersandte ich eine ziemlich genaue Zeichnung davon an Herrn Dr. H. HAGEN in Königsberg, welcher die Güte gehabt hat, seine Ansicht über dieses einzige Exemplar mir in nachstehenden Worten mitzulheilen.

Königsberg, den 20. Febr. 1865.

Der Flügel aus dem Rothliegenden — also doch zwischen Kohle und Perm, und näher der ersteren — interessirt mich in hohem Grade und es wird mir schwer, zu einem bestimmten Schlusse zu kommen. Die Zeichnung, so anscheinend schön sie ist, reicht doch nicht aus, und ich meine, der Stein muss mehr sehen lassen, als die Zeichnung zeigt. Dass letztere in den feineren Details nicht durchaus richtig ist, beweist eine Stelle, an welcher die Queradern über zwei dachförmig gebrochene Felder in einem Striche fortlaufen. Ich fürchte aber, eine Photographie wird sie auch kaum fördern. Derartige Stücke können nach meiner Erfahrung nur mühsam unter der Lupe entziffert werden.

Jedenfalls halte ich das Fossil für neu, oder vielmehr richtiger, meines Wissens unbeschrieben. Gehen wir bei seiner Deutung durch Exclusion vor, so stellt die Anordnung der Adern es zweifellos sicher, dass das Thier nur zu den Orthopteren oder Neuropteren gehört haben kann. Fassen wir die Neuropteren im Sinne ERICHSONS (Hemerobiden, Sialiden, Panorpen, Phryganiden), so kann bei einem Vergleich mit dem Fossil nur von den Sialiden die Rede seyn. Die Phryganiden werden durch den fast gänzlichen Mangel an Queradern (die bei dem Fossil so zahlreich sind) sogleich ausgeschlossen, und auch unter den Sialiden zeigen *Corydalids* und *Chauliodes* niemals so zahlreiche und dicht stehende Queradern als das Fossil.

Unter den Orthopteren werden die *Orthoptera* im engeren Sinne, namentlich die Heuschrecken, durch das Geäder ausgeschlossen. Es sind bei denselben die Längsadern im Basaltheil des Hinterfeldes meist wenig häufig, aber in jedem Falle gerade, und nicht gekrümmt und gegabelt wie bei dem Fossil. Es bleiben also von den Orthopteren zum Vergleiche nur die sogenannten Pseudoneuropteren übrig (*Termes*, *Psocus*, *Perla*, *Libellula*, *Ephemera*). Es stellt sich sogleich heraus, dass unter diesen nur an *Libellula* und *Ephemera* gedacht werden kann. Nehmen wir zuvörderst die Odonaten in's Auge, so existirt in den secundären Schichten Englands und Solenhofens eine noch wenig gekannte Gattung mit breiten kurzen Hinterflügeln, sehr dichtem *Polyneura*-artigen Geäder, und der merkwürdigen, in der lebenden Fauna ganz anomalen Anordnung, dass das Dreieck der Hinterflügel genau wie das der Vorderflügel der Libellulinen (im engeren Sinne) gebildet ist. BRODI, fossile Ins. tab. 5, f. 10, bildet als *Lib. antiqua* den Basaltheil schlecht ab, und WESTWOOD, *Quat. Journ. Geol. Soc.* Vol. X, tab. 15, f. 5 stellt fast den ganzen Flügel dar. Unter den Solenhofener Arten gehören die her, die ich in meinem vorläufigen Verzeichniss *Lib. densa* und *abscissa* genannt habe. Studirt habe ich diesen Theil der Odonaten noch gar nicht, da ich gegenwärtig noch mit Bearbeitung der Gomphiden beschäftigt bin. Auch sind nur wenige Exemplare bis jetzt in Solenhofen entdeckt. Beim Vergleich der zuletzt citirten Abbildung mit der Zeichnung werden Sie mir beistimmen, dass man sehr berechtigt ist, an ein Hergehören zu denken. Gerade dieser Umstand hat mich meine Meinung so lange zurückhalten lassen und ich bin auch noch nicht mit mir ganz einig. Es fehlen allerdings der Versteinerung Basis und Spitze, also die zur Entscheidung wichtigsten Theile, und der Nodus, der sichtbar seyn müsste, ist in der Zeichnung nicht angedeutet. Dieser Umstand würde bei eigener Ansicht des Stückes möglicher Weise leicht zu entscheiden gewesen seyn. Wie dem nun auch sey, ich halte mich nur an die Zeichnung, und selbe schliesst durch den Mangel des Nodus die Odonaten aus.

Sie haben offenbar sehr richtig an die *Ephemera* gedacht. Diese merkwürdige Familie ist eigentlich trotz der Monographie PICTET's noch sehr unvollkommen gekannt, und enthält schon

unter den lebenden Thieren Anomalien des Geäders von beträchtlichem, in der Litteratur ungeahntem Umfange, besonders bei exotischen Arten. Unter den bekannten Gattungen wird also (und darauf bezieht sich wohl auch Ihre Bemerkung von *Eph. vulgata*) nur an *Ephemera* und *Palingenia* zu denken seyn. Namentlich zeigt letztere (jetzt durch WALZ und mich in 7 Genera gespalten) einige nahe stehende Formen. Aber auch hier lässt mich die Zeichnung in Betreff des Ursprungs der Längsadern wieder ganz im Stich und ich meine, dass das Stück darin deutlicher seyn muss.

Unter den Ephemeriden ist aber noch an zweierlei besonders zu denken, und ich erlaube mir Ihre Aufmerksamkeit darauf hinzulenken; GOLDENBERG hat in MEYER's *Palaeontogr.* 1854 aus der Kohle drei Arten einer neuen Gattung *Dictyoneura* beschrieben, die er *Corydalis* (also den Neuropteren) nahe stellt. Nach den Abbildungen zu urtheilen gehört aber eine Art davon bestimmt in eine differente Gattung und zu Ephemeriden; die beiden andern wahrscheinlich auch zu den Ephemeriden. Ferner führen die Solenhofener Schichten Thiere, die bis jetzt nur durch sehr unvollständige Stücke bekannt sind; ich habe sie *Ephem. cellulosa* und *procera* genannt; beide Arten entsprechen den beiden Gattungen, die GOLDENBERG unter dem Namen *Dictyoneura* vereint hat. Endlich spricht dafür, dass alle diese Thiere zu den Ephemeriden wirklich gehören, der Umstand (wenigstens für mich), dass kürzlich in Sibirien (ich meine bei Irkutsk) eine gigantische Ephemeriden-Larve in ähnlichen Schichten entdeckt ist; Herr v. EICHWALD, der sie im dritten Theile seines Werkes beschreiben will, hat mir vor einigen Monaten eine Abbildung des Thieres vorgelegt.

Es sind bis jetzt in den Kohlen, Perm und dem zwischen gehörenden rothen Sandstein keine Odonaten, wohl aber *Corydalis* und Ephemeriden-Flügel und Larven entdeckt und zu letzteren werden wir Ihr Fossil zu rechnen haben. Jede weitere Deutung ist nach der Zeichnung allein misslich, ich bemerke nur, dass alle eben erwähnten, beschriebenen Arten wesentlich kleiner sind.

H. HAGEN.

Bezüglich hierauf muss ich noch bemerken, dass die auf Taf. II, Fig. 1 wiedergegebene Abbildung auf Grund einer neuen, durch Herrn M. KRANZ in Dresden ausgeführten, möglichst genauen Zeichnung ausgeführt worden ist, welche Herrn Dr. H. HAGEN noch nicht vorgelegen hat, welche indess, wie ich glaube, die von Dr. H. HAGEN ausgesprochenen Ansichten von neuem bestätigen wird.

2) *Leaia Baentschiana* GEIN. — Taf. II, Fig. 2 und 3.

Zu dieser schon Jahrb. 1864, S. 657 beschriebenen Art, die durch Hrn. Referendar BAENTSCH in einem dünnschieferigen gelblich-grauen Schieferthone der unteren Dyas von Werschweiler oder Wiebelskirchen bei Neunkirchen entdeckt worden ist, folgen hier Abbildungen in natürlicher Grösse (a) und in vierfacher Vergrösserung (A).

3) *Anthracomya elongata* SALTER. — Taf. II, Fig. 4-7. — SALTER, *Quat. Journ. of the Geol. Soc.* 1863, V. XIX, p. 79, f. 1.

Diese Art umfasst kleine, dünnchalige, concentrisch gestreifte Muscheln von schief eiförmiger Gestalt mit einem geradlinigen Schlossrande, über welchem ein kleiner stumpfer Wirbel, der im vorderen Dritttheile dessen Breite liegt, nur wenig hervorragt.

Durch diese beiden flügelartigen Ausbreitungen der Schale vor und hinter dem Wirbel, von denen die vordere klein und gerundet, die hintere grösser und stumpfwinkelig ist, nähert sich *Anthracomya* den Gattungen *Gervillia*, *Modiola* u. a. Zähne scheinen zu fehlen. Man findet Andeutungen von radialen Linien, die jedoch meist nur in der Mitte des äussersten Schalenrandes hervortreten.

Vorkommen: Im schwarzen Schieferthone über dem Eduardflötze bei Witkowitz unweit Mährisch Ostrau, von wo wir diese Schalen dem dortigen Bergmeister verdanken.

Das von SALTER beschriebene Original ist von DAWSON in den Steinkohlengruben Neu-Schottlands entdeckt worden.

4) *Holoptychius Portlocki* AG. — Taf. II, Fig. 8-19. — PORTLOCK, *Report on the Geology of the county of Londonderry*. Dublin, 1843. p. 463 z. Th., Pl. XIII, f. 1-4. (Nicht f. 5-11, die zu *Rhizodus Hibberti* AG. gehören.*

* Vgl. M'Coy, *a Synopsis of the Classification of the British Palaeo-*

Aus der Rudolphgrube bei Volpersdorf in der Grafschaft Glatz ist mir durch Herrn Obersteiger VOELKEL, sowie durch Herrn E. LEISNER in Waldenburg eine Anzahl von Fischresten zugesandt worden, welche mit Pflanzenresten zusammen in der mittleren Abtheilung der dortigen Steinkohlenformation vorkommen. Am deutlichsten sind die Fischschuppen, welche im Wesentlichen so nahe mit den Abbildungen PORTLOCK's übereinstimmen, dass diese aus den Steinkohlenlagern Irlands beschriebene Art hier unmöglich verkannt werden kann. Unsere Abbildungen auf Taf. II, welche diese Schuppen in allen Grössen darstellen, zeigen sie durch Missverständniss des Zeichners allerdings in einer entgegengesetzten Stellung von derjenigen, die ihnen PORTLOCK gegeben hat, was indess einen Vergleich zwischen beiden nicht stören kann.

Der Umriss der Schuppen ist bald länglich-oval, bald kreis-oval, meist länger als breit, zuweilen auch breiter als lang, und es liegt dann die grösste Breite in der Nähe des freien Hinterandes der Schuppe, welche am häufigsten nur schwach gerundet ist, während der vordere bedeckte Theil der Schuppe sich mehr oder weniger deutlich verengt und zuweilen sogar in eine Ecke vorspringt.

Der hintere Theil der Schuppe ist mit sehr feinen, der vordere Theil mit stärkeren radialen Linien dicht besetzt, welche durch concentrische Anwachsringe durchbrochen werden, während der übrige freie Theil der Aussenfläche nur mit sehr feinen concentrischen Linien verziert ist, die bei Vergrösserung körnig erscheinen. Ihre körnige Beschaffenheit tritt in einem weit höheren Grade auf der inneren Fläche der Schuppe hervor, wo sie in Folge der Durchkreuzung der zarten Anwachslinien und ausstrahlenden Linien an allen Stellen schön zu beobachten ist. Sie ist von PORTLOCK sehr gut dargestellt worden.

Der vordere Theil der Schuppe, welcher von einer anderen Schuppe bedeckt gewesen ist, zeigt bei allen grösseren Exemplaren eine grosse Anzahl mit einander verschmolzener Höcker, welche Fig. 17—19 in natürlicher Grösse, und 17 A etwas ver-

grössert darstellen, während ähnliche grössere Höcker zuweilen auch an anderen Stellen der Oberfläche erscheinen (Fig. 19), wo sie an anderen Schuppen dieser Art zu fehlen pflegen.

Mit diesen Schuppen sind pfriemenförmige Zähne oder kleine Flossenstrahlen zusammen vorgekommen, welche sehr spitz sind und einige Längsrippen oder Furchen wahrnehmen lassen (Fig. 20 und 21), sowie der Fig. 22 abgebildete flach lanzettförmige Knochen, welcher unregelmässig längsgestreift ist und mit einem anderen flachen dreieckigen Knochen zusammenliegt. Die letzteren lassen keine sichere Deutung zu.

Ein Fig. 23 und 24 abgebildeter Körper, der an dem unteren (hinteren Rande) mehrere Einschnitte wahrnehmen lässt, erinnert am meisten an die Schuppe eines Ctenoiden der jüngeren Formationen.

5) *Noeggerathia foliosa* STERNB. — Taf. III, Fig. 1, 2. — STERNBERG, Flora d. Vorwelt. V. I. 1825. 3, p. 28, tb. 20.

Die erste Abbildung dieser Art stellt ein Blatt mit nur einer Reihe von Blättchen dar, da die andere Reihe daran verloren gegangen war. Eine bessere Abbildung gab GÖPPERT in den »Gattungen der fossilen Pflanzen, Lief. 5 und 6, S. 108, tb. XII, f. 1. In neuerer Zeit wurde diese Pflanze weit vollkommener und schöner auf der Adalberti-Zeche des Herrn SCHUPANSKY bei Rakonitz, sowie auch bei Bras im Radnitzer Becken und in dem Wenzel-Schachte bei Kladno gefunden. Von ihrer Fruktifikation ist bisher noch Nichts veröffentlicht worden. Dieser Fruchtstand entspricht ganz den Erwartungen, die man sich nach den Untersuchungen von BRONGNIART über die Familie der Noeggerathien und nach der Stellung, die er derselben unter den nacktsamigen Dicotyledonen angewiesen hat, davon machen konnte.

Breite blattartige Fruchtblätter, deren oberes freies Ende zerschlitzt, befestigen sich mit einer keilförmig zusammengeschnürten Basis an einer gemeinschaftlichen Axe und dienen auf ihrer inneren Seite als Träger einer grösseren Anzahl elliptischer Früchte, deren unteres Ende in einen dünnen Stiel verläuft, wie dies an der Fruchtgattung *Rhabdocarpus*, die wir schon früher auf *Noeggerathia* zurückgeführt haben, längst bekannt ist.

Diese Fruchtkapseln, von welchen unsere Abbildung Fig. 1 eine grössere Anzahl in ihren verschiedenen Entwicklungsstufen

zeigt, lassen eine etwas unregelmässig halbkreisförmige Anordnung wahrnehmen, welche im Allgemeinen dem äusseren Umfange des Fruchtblattes entspricht. Im vorgerückteren Alter sind sie rundlich oder verkehrt-eirund mit etwa 4^{mm}. Durchmesser nach ihrer Breite.

Man wird durch Lage und Ausbildung dieser Früchte sehr an die Coniferen erinnert, insbesondere an *Voltzia* (vgl. GÖRPERT, Monographie der fossilen Coniferen. Leiden, 1850. tb. 23), bei denen indess nur 2 Saamen unter jeder Fruchtschuppe vorhanden sind, während bei *Noeggerathia*, wie gezeigt, eine weit grössere Anzahl zur Entwicklung gelangt.

6) *Graminites Feistmanteli* GEIN. — Taf. III, Fig. 3.

Der flachgedrückte, gegen 4^{mm}. breite Stengel ist gerade, fein gestreift und, wie der Halm eines lebenden Grases mit entfernt stehenden Knoten versehen. Zwei solcher Knoten sind mit den Buchstaben a, a bezeichnet worden. Lineare Blätter von nahe 2^{mm}. Breite, die mit feinen parallelen Linien dicht bedeckt sind, und aus halbumfassenden Scheiden herauszukommen scheinen, stehen in unregelmässigen Entfernungen, meist unter spitzen Winkeln um den Stengel herum.

Dies dürfte das erste wirkliche Gras seyn, das in der Steinkohlenformation gefunden worden ist. Es stammt aus dem grauen Schieferthone des Pilsener Beckens von Bras, wo es Herr Hüttenmeister FEISTMANTEL entdeckt hat, in dessen Sammlung es sich auch befindet.

7) *Sigillaria Feistmanteli* GEIN. — Taf. III, Fig. 4.

Diese in die Gruppe *Rhytidolepis* von GOLDENBERG gehörende Art schliesst sich denjenigen Formen an, bei welchen die Längsrippen sich abwechselnd erweitern und verengen und daher durch wellenförmige Furchen von einander getrennt sind. Die grossen spitz-eiförmigen Narben, welche im Quincunx von $\frac{1}{2}$ angeordnet sind, werden ihrer Länge nach durch einen nur ein halb so langen, querrunzeligen Zwischenraum von einander geschieden, während ihr breitester Theil im unteren Drittheile der Narbe zugleich auch den breitesten Theil der ganzen Längsrippe bezeichnet. Die beiden linienförmigen Einschnitte und der von ihnen eingeschlossene Punkt für den Durchgang der Blattnerven fallen in das obere Drittheil der Narbe. Der Rand der letzteren

ist nach oben hin scharf, nach unten aber nur schwach begrenzt, wodurch es den Anschein gewinnt, als ob langgezogene elliptische Narben unmittelbar aneinander stiessen, was jedoch nicht der Fall ist.

Am meisten nähert sich diese Art wohl der *Sig. coartata* GOLDENB., *Flora Sarapontana fossilis*, 1857, II, p. 36, tb. 9, f. 3, bei welcher jedoch die senkrechten Abstände der Narben weit bedeutender sind.

Vorkommen: In der Steinkohlenformation von Bras im Radnitzer Becken, von wo ich sie Herrn Bergmeister FEISTMANTEL verdanke.

8) *Caulopteris gigantea* GOLDENBERG sp. — Taf. III, Fig. 5 in $\frac{1}{2}$ der wirklichen Grösse.

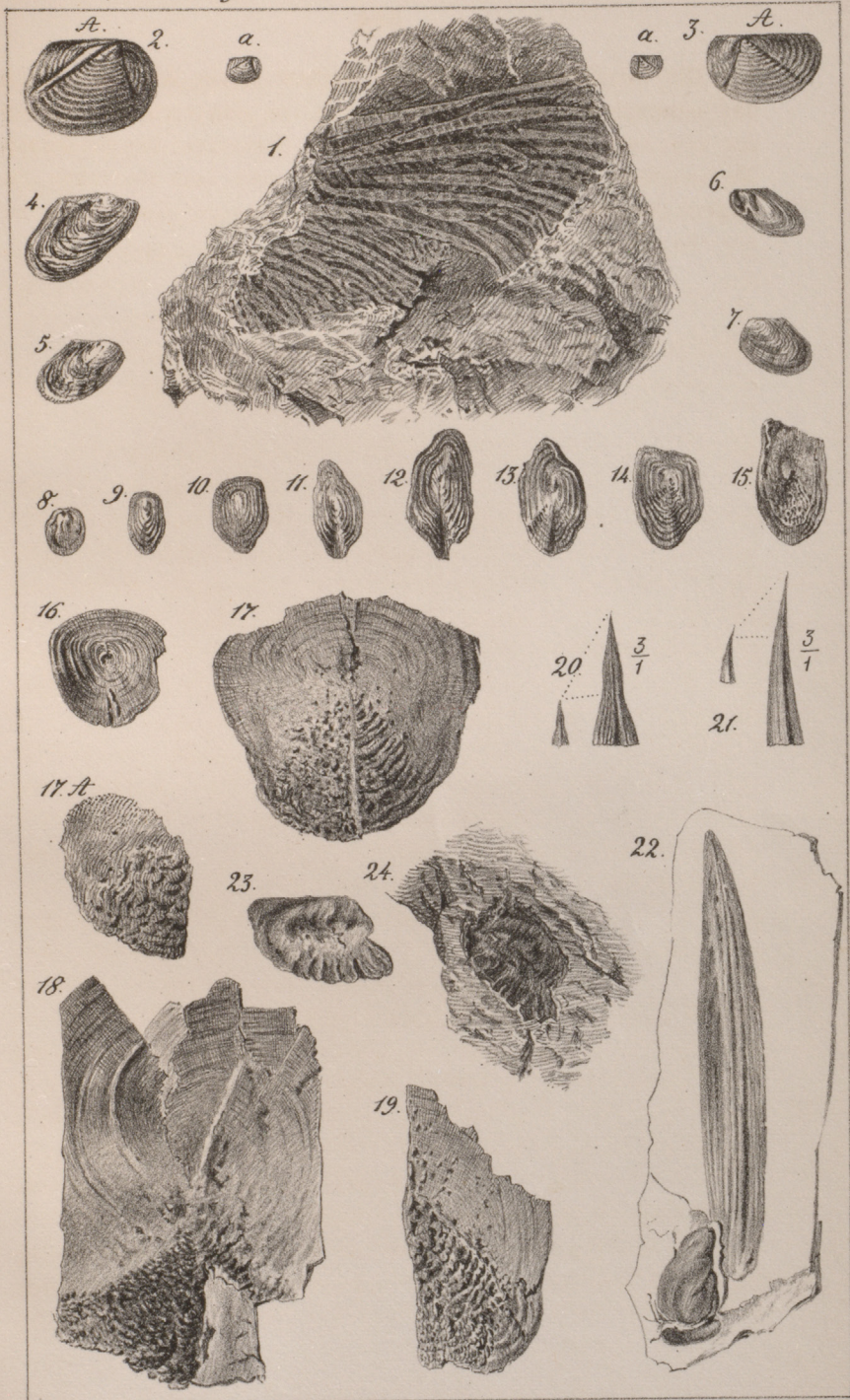
Es liegt uns ein Stammstück mit drei grossen Narben aus dem thonigen Sandsteine von Pletzach im Radnitzer Becken vor, das wir, sowie die unter 5 bis 7 beschriebenen Formen, Herrn Hüttenmeister FEISTMANTEL in Bras verdanken. Es dürfte mit *Megaphytum giganteum* GOLDENBERG, *Flora Sarapontana fossilis*, I. Saarbrücken, 1855. P. 19, tb. II, f. 9, identisch seyn, ist jedoch noch besser erhalten und veranlasst uns, diese Art von der Lycopodiaceen-Gattung *Megaphytum* zu entfernen und sie vielmehr zu der Farren-Gattung *Caulopteris* zu stellen.

Eine jede der drei grossen ovalen Narben greift mit ihrem unteren, etwas verengten Ende unter das breite obere Ende der tiefer liegenden Narbe fast zapfenartig ein. Jede derselben lässt mehrere blätterige Lagen wahrnehmen, von denen die äusseren sich allmählig verkürzen, wodurch jene Querrisse Erläuterung finden, welche GOLDENBERG darauf abgebildet hat.

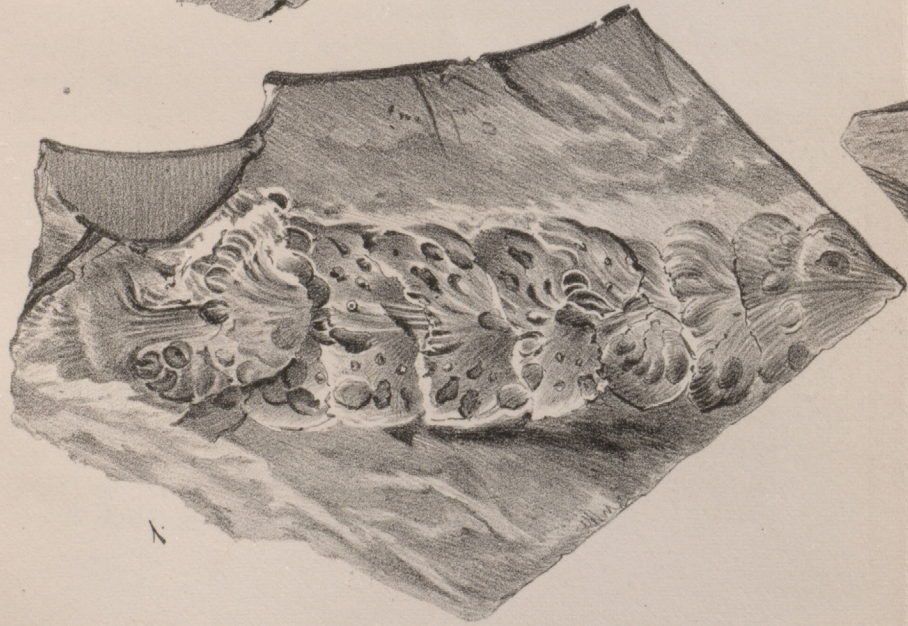
Die in der oberen Hälfte der Narbe blossliegenden Blätterlagen sind mit kurzen, wulstförmigen Höckern bedeckt, wie man dieselben in einer ganz ähnlichen Weise bei *Caulopteris Cisti* BRONGN. sp., *C. peltigera* BRONGN. sp. (vgl. GEINITZ, Verst. d. Steinkohlenf. in Sachsen tb. XXXIV) und anderen Baumfarren antrifft, welche Luftwurzeln entsprechen.

Dieselben sind im Allgemeinen unregelmässig gestellt und zeigen nichts weniger, als eine radiale Anordnung, wie man dieselbe wohl auf den Astnarben von Lycopodiaceen anzutreffen pflegt.

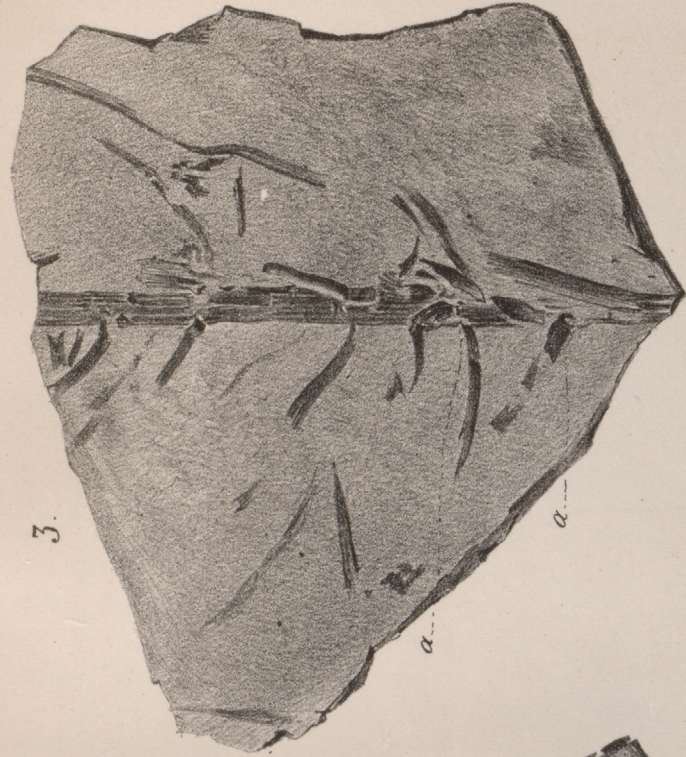
Die Oberfläche der grossen Narben dieser Art ist convex und unterscheidet sich auch hierdurch von den vertieften Narben der von ARTIS, LINDLEY, STERNBERG und BRONGNIART beschriebenen *Megaphytum*-Arten. Ich glaube, dass man kein Bedenken zu tragen braucht, *Megaphytum giganteum* GOLDENBERG zu *Caulopteris* zu stellen.



1. *Ephemerites Rückerti* Gein. (Dyas), 2-3. *Leaia Baentschiana* Gein (Dyas), 4-7. *Anthracomya elongata* Salter, 8-19. *Homotrypa Portlocki* Ag. 20-24. *Piscium reliquia*.



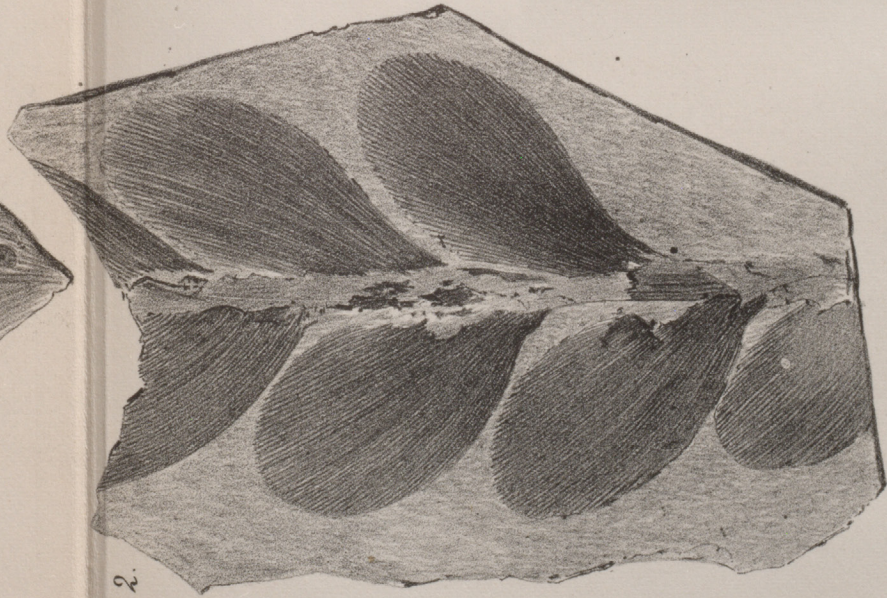
1.



3.

a

a



2.



5.

$\frac{1}{2}$



4.



4. A.

$\frac{2}{1}$

1-2. *Noeggerathia foliosa* St., 3. *Graminites Feistmanteli* Gein. 4. *Sigillaria Feistmanteli* Gein.
5. *Caulopteris gigantea* Goldenb. sp.

Über das Vorkommen von Baumfarn in der fossilen Flora, insbesondere in der Kreideformation,

von

Herrn Geh.-Rath Dr. **Göppert.**

Baumartige Farn treten in der fossilen Flora zuerst in der oberen Steinkohlenformation auf, in dem Rothliegenden erreichen sie das Maximum an Artenzahl. Die Trias (der bunte Sandstein und Keuper) haben nur wenige Arten aufzuweisen, aus dem Oolith ist mir keine Art bekannt, erst in der Kreideperiode kommen sie wieder vor.

Unter den zahlreichen, insbesondere bei Aachen beobachteten Farn sind zwar viele sehr interessante Formen, aber doch keine baumartigen, deren Vorkommen sich bisher auf Schlesien beschränkte, woran man aber bis jetzt zweifelte, woran ich früher zum Theil selbst die Schuld trug. Als ich nämlich einen solchen, die *Caulopteris Singeri* aus der Quadersandsteinformation in Giersdorf bei Löwenberg, bereits in meiner ersten Schrift über die fossilen Farn im J. 1836 veröffentlichte, zog ich den Fundort selbst in Zweifel, weil man damals gewohnt war, dergleichen nur in der Steinkohlenformation erwarten zu dürfen. Später aber bestätigte sich die Richtigkeit der ersten Angabe vollkommen, wie ich auch schon in meiner 5 Jahre später erschienenen Schrift über die Quadersandsteinformation *Nov. Acta Acad. N. C. Vol. XIX. P. II, p. 21. 1841* ausdrücklich angab, und auch eine genauere, auf ein besseres Verständniss des merkwürdigen Stammes sich gründende Abbildung lieferte, so dass die Verfasser der trefflichen Aachener Kreideflora wohl nicht nöthig hatten, diese in-

interessante Pflanzen aus der Reihe der Kreidepflanzen zu streichen und eine abermalige Verification meiner Angaben zu verlangen. (DEBEY und C. v. ETTINGSHAUSEN, die urweltlichen Acrobyen des Kreidegebirges von Aachen und Mastricht p. 65.) Nun diese geschieht hiermit und aus der nachfolgenden Auseinandersetzung wird hervorgehen, dass meine geehrten Freunde sich noch zu ganz anderen Concessionen nach dieser Richtung hin werden entschliessen müssen. Die ausserordentliche Ähnlichkeit der in Rede stehenden Pflanze mit der berühmten *Caulopteris punctata* STERNBERG., später *Protopteris Sternbergii* CORDA, durch welche im J. 1821 zuerst die ganz unzweifelhafte Gegenwart der Baumfarn in der Flora der Vorwelt überhaupt festgestellt wurde, erregte in mir oft die Vermuthung, dass auch diese wohl dem Quadersandstein angehören möge. Doch der Formationszwang, so zu sagen, hielt diese Zweifel nieder, bis denn nun in der That mein Freund REUSS, und zwar schon im Jahre 1852 (Jahrb. der geol. Reichsanstalt, III. Jahrg., No. 2, p. 105), erklärte, dass die Sandsteine von Kaunic, ihr Fundort, sogar über dem Rothliegenden lagern und ohne allen Zweifel den unteren Schichten der mittleren Kreide oder unteren Quadersandsteinformation zuzurechnen seyen. Von dieser wohl nur in 2—3 Exemplaren bekannten Pflanze besitze ich ein sehr wohl erhaltenes, welches mir einst im Jahre 1837 mein hochverehrter Freund, Graf CASPAR v. STERNBERG, zu schenken so gütig war. Eine schon längst angefertigte, möglichst treue Zeichnung soll zugleich mit der von C. *Singeri* veröffentlicht werden, woraus sich unzweifelhaft ergeben wird, dass diese also für die Kreideformation neu gewonnene Art von C. *Singeri* nicht verschieden, und letztere als die später benannte mit ihr zu vereinigen ist.

Ein sehr gerechtfertigtes Aufsehen erregte im Jahre 1836 BERNHARD v. COTTA's Entdeckung eines noch treffliche Strukturverhältnisse zeigenden Farnstammes-Bruchstückes (LEONH. und BRÖNN, Jahrb. 1836, p. I, p. 30, tab. I, fig. 2), welches im Äusseren der *Protopteris Sternbergii* so ähnlich war, dass es der Entdecker mit dem damals noch geltenden Namen *Lepidodendron punctatum* bezeichnete.

Erst später wurde es als *Protopteris Cotteana*, jenes, das *Lepid. punctatum*, als *Protopteris Sternbergii* bezeichnet. Sicher

trug auch hier die Rücksicht auf die Formation viel zur Benennung bei: denn es war auf entschieden secundärer Lagerstätte bei Grossenhayn in Sachsen gefunden worden und es musste es sich gefallen lassen, bald als ein Flüchtling der Steinkohlenformation, bald des Rothliegenden aus Böhmen betrachtet zu werden. Unerwartet erhielt ich im Jahre 1860 von Oppeln in Schlesien aus dem unmittelbar an der Stadt gelegenen Kreidekalkbruche der Turonischen Gruppe einen versteinten, dem *Cottae*-schen an Grösse und Äusseren täuschend ähnlichen Stamm, welcher sich auch in der That als identisch erwies, leider mir aber, als ich ihn eben hatte schleifen lassen und mich nun zu genauerer Untersuchung desselben anschickte, auf mir völlig unerklärbare Weise verloren ging, so dass ich nicht im Stande bin, auch für Andere den thatsächlichen Beweis der Identität zu führen. Für mich unterliegt es keinem Zweifel, dass *Protopteris Cottae* nichts anderes ist, als ein noch mit Struktur erhaltener Stamm von *Protopteris Sternbergii*, der nur in der Form des Steinkerns vorliegt. Unter den lebenden mir bekannten Farn kommt *Protopteris Sternbergii* im Äusseren *Hemitelia horrida* am nächsten.

Inzwischen sollte ich bald für diesen freilich nur schwer zu verschmerzenden Verlust aus demselben Fundort durch eine Acquisition entschädigt werden, wie sie der wissenschaftlichen Untersuchung in dieser Richtung hin bis jetzt noch niemals zu Theil geworden ist, und zwar wieder durch einen Farnstamm von 2 Fuss Länge, der nur mässig zusammengedrückt mit seinem unteren Ende vollständig erhalten vorliegt und so eine Anschauung von der Beschaffenheit der vorweltlichen Farn, insbesondere der Luftwurzeln zum eigentlichen Stamm selbst gewährt, wie sie sämtliche bisher nur in Bruchstückform erhaltene fossilen kraut-, strauch- oder baumartigen Farn bis jetzt nicht zu geben vermochten. Ganz und gar mit braun gefärbten Luftwurzeln bedeckt, zwischen denen die Blattnarben nur am obern Theil deutlich hervortreten, glaubt man beim ersten Anblick einen lebenden Farnstamm vor sich zu sehen, da die äusseren Lagen der Luftwurzeln nur locker verbunden und erst mehr nach dem Innern hin durch strukturlose, hornsteinartige Kieselmasse fest unter einander vereinigt erscheinen.

Die parenchymatösen und prosenchymatösen Zellen der Luftwurzeln enthalten noch viel von ihrer organischen Substanz, daher ihre braune Färbung, das Gefässbündel in der Mitte ist frei davon, liegt wie ein kleiner weisser Fadenwurm in der Mitte und gewährt der mikroskopischen Betrachtung in anatomischer Hinsicht ein höchst interessantes Präparat, indem die Tüpfelkanäle der punktirten Zellen und Treppengefässzellen hier als Erhabenheiten sich darstellen, die bei den lebenden als Vertiefungen in den secundären Schichten erscheinen, wie H. v. MOHL uns zuerst im Jahre 1828 lehrte, eine Entdeckung, die wohl zu den glänzendsten gehört, welche die Wissenschaft diesem ausgezeichneten Forscher verdankt. Nicht ohne einige Schwierigkeit gelang es nun auch, einen Querschliff des ganzen Stammes zu erhalten und den eigentlichen, von den Luftwurzeln umgebenen Holzcyylinder darzulegen, der im Verhältniss zum Umfange des Ganzen sich von sehr geringem Durchmesser erwies, jedoch durch seine Verschiedenheiten von dem Inneren des *Protopteris Cottae* jeden Gedanken der Identität mit demselben zurückwies, woran ich anfänglich zuweilen dachte. Er gleicht nicht der *Alsophila nigra*, sondern der von ihr sehr abweichenden *A. ebenina*, einigermaßen auch *A. pruinosa* KLF. der Jetztwelt (vergleiche KARSTEN, über die Vegetationsorgane der Palmen p. 165, Tab. 9, Fig. 1—4). Mein Freund, Herr Dr. STENZEL, Verfasser der vortrefflichen Arbeiten über die Staarsteine, hat die anatomische Untersuchung desselben geliefert, die meinem Werke über die Kreideflora unseres Gebietes zu nicht geringer Zierde gereichen wird. Es sey nur erlaubt, aus derselben schon jetzt anzuführen, dass so auffallend dünne Gefässbündelplatten, wie auch eine so grosse Entfernung derselben von der äusseren festen Rindenschicht bis jetzt kaum an einem anderen lebenden und fossilen Baumfarn gefunden ward. Von allen anderen aber entfernt unseren Stamm der gänzliche Mangel einer ausgeprägten Prosenchymscheide um die Gefässplatten und die geringe Zahl der dünnen, fadenförmigen, in die Blattnarbe eintretenden Gefässbündel. In allen diesen Punkten nähert er sich ebenso sehr den krautartigen Farn, so dass er wesentliche Merkmale beider Wachstumsformen in sich vereinigend als eine merkwürdige Mittelbildung zwischen ihnen zu betrachten ist. Wegen seines übergrossen Reichthums an Luft-

wurzeln, welche durch kein parenchymatöses Gewebe untereinander verbunden sind, wie dies bei den Stammfarnen gefunden wird, haben wir diesen Stamm *Rhizodendron* und von seinem Fundort *oppoliense* genannt.

Mit allen diesen Baumfarn erscheint noch eine andere von CORDA auf Resten von Blattstielen gegründete Gattung *Tempskya* verwandt, deren Holzcyylinder bis jetzt noch nicht aufgefunden worden sind, wie wir auch ihre Fundorte oder vielmehr ihre Lagerstätte nicht genau kennen. *Tempskya pulchra* stammt aus dem Gerölle der Elbe, *Tempskya macrocaule* aus dem aufgeschwemmten Lande, die dritte, *T. microrrhiza*, muthmasslich aus Böhmen, erhielt er von unserem Freunde REUSS. Die beiden ersten nicht sehr von einander verschiedenen Arten empfing ich ebenfalls von REUSS aus dem Quadersandstein von Tzibitz, die letztere aus dem von Strassnik bei Rakonitz, welche ebenfalls der Kreideformation zuzuzählen sind, so dass sich also die Zahl der bis jetzt in der Kreideformation beobachteten Baumfarn auf 5 beläuft. Dass diese baumartigen, der Kreideformation angehörigen Farren also aus der Permischen Flora zu entfernen seyen, wohin ich sie noch jüngst gerechnet habe, versteht sich nun von selbst. Ein sechster aus dem Überquader von Ullersdorf trat noch jüngst hinzu, der auch in der bald herauszugebenden Kreideflora abgebildet und beschrieben werden soll, wie noch einzelne fructificirende Farn (*Gleichenia Drechsleriana* m.), welche bei weiterer Nachforschung eine Ähnlichkeit mit der gleichalterigen Art erwarten lassen.

Die Umwandlungs-Produkte alter Bronzen.

Ein Beitrag zur Genesis einiger Kupfererze, insbesondere des
Kupferoxyduls

von

Herrn Dr. **F. Wibel.**

Die Umwandlungen, welche Bronze-Gegenstände durch ihre lange Lagerung im Erdboden oder im Wasser erlitten haben, sind schon frühe und von Seite hervorragender Forscher (SAGE, DEMESTE, DE MORVEAU, KLAPROTH, NÖGGERATH, VAUQUELIN etc.) in ihrer Bedeutung für die Mineralogie erkannt worden. Aber nicht bloss in dieser Beziehung, sondern auch in anderen haben dieselben als Beispiele für gewisse Erscheinungen gedient, wie denn z. B. J. DAVY und G. BISCHOF * in dem Auftreten krystallisirten Rothkupfererzes eine besondere Art der Krystallisation im starren Zustande und BECQUEREL in der eigenthümlichen, von Aussen nach Innen fortschreitenden Veränderung der Gegenstände einen unterstützenden Beleg zu der von ihm allgemeiner angenommenen »Cementation« zu erkennen glaubten. Ganz besonders ist es jedoch jene erste Bedeutung, welche auch in neuerer Zeit zu einem Studium der Bronzen Veranlassung gab und beispielsweise von CHEVREUL (1856) und REUSS (1860) ** mit Recht vorangestellt wurde. Da ich nun Gelegenheit hatte, einige solcher alter Bronzen zu untersuchen, möge es mir gestattet seyn, die Ergebnisse

* G. BISCHOF, Lehrb. d. physik. u. chem. Geologie. 1. Aufl. II, 227 und 2046.

** A. REUSS in diesem Jahrbuche 1860, S. 813.

Beiträge zur älteren Flora und Fauna

von

Dr. H. B. Geinitz.

(Mit Tafel III.)

1. Die fossile Flora in der Steinkohlen-Formation von Portugal

nach B. A. GOMES.

Eine gedrängte Schilderung der Steinkohlenreviere in Portugal ist nach den bis zu dieser Zeit vorhandenen Quellen in unserem grösseren Steinkohlenbuche »die Steinkohlen Deutschlands und anderer Länder Europa's, von H. B. GEINITZ, H. FLECK und E. HARTIG, München, 1865. I, p. 340—344« gegeben worden. Es gereicht uns zur grossen Genugthuung, hier aussprechen zu können, dass die dort vertheidigten Ansichten über das Alter dieser Steinkohlenlager, die wir a. a. O. S. 406 in die vierte Hauptzone der Steinkohlenzeit, die Annularienzone, versetzt haben, durch die neuesten Untersuchungen darüber nur Bestätigung finden. In einer Abhandlung der *Commissão Geologica de Portugal*, welche den Titel führt: *Flore fossile du terrain carbonifère des environs du Porto, Serra do Bussaco, el Moinho d'Ordem près d'Alcacer do Sal*, par BERNARDINO ANTONIO GOMES, Lisbonne, 1865« (4^o. 44 S., 6 Taf.), erhält man näheren Aufschluss über sämtliche in den verschiedenen Steinkohlenrevieren Portugals bis jetzt aufgefundene Pflanzenreste.

Wir bedauern nur, dass der Text nicht von einer grösseren Anzahl Abbildungen begleitet ist, um auch die Richtigkeit aller Bestimmungen von neuem prüfen zu können, was ohne dieselben oder ohne Originale geradezu meist unmöglich ist. Blickt auch

überall die Mühe hindurch, die sich der Verfasser gegeben hat, die Wahrheit zu finden, so hat man doch in vielen Fällen noch keine Garantie dafür, dass sie auch wirklich gefunden ist.

Bei der Wichtigkeit des Gegenstandes, welcher in dieser Abhandlung von GOMES behandelt worden ist, können wir nicht unterlassen, das, was hier gegeben ist, etwas näher zu beleuchten.

Die geologischen Formationen, worin man diese Steinkohlenpflanzen in Portugal aufgefunden hat, sind auf die Umgebungen von Porto, von Bussaco und von Moinho d'Ordem in Alemtejo bei Alcacer do Sol beschränkt. Am wichtigsten unter diesen sind in Bezug auf Gewinnung von Kohlen die bei Porto, besonders in dem Concelho de Gondomar, wo sie das Steinkohlenbassin von S. Pedro da Cova bilden, welches durch CARLOS RIBEIRO genauer beschrieben worden ist (Jb. 1862, p. 257 bis 283).

Bei Bussaco ist die Menge der vorhandenen Kohlen unbedeutend, indess finden sich dort zahlreiche Pflanzenreste, welche schon in CHARLES J. F. BUNBURY einen gründlichen Monographen gefunden haben. Bei Moinho d'Ordem ist die zu der Steinkohlenformation gehörende Reihe von Gebirgsschichten, ebenso wie die der dort vorkommenden Pflanzenreste, sehr beschränkt und die Kohle selbst fehlt, vielleicht in Folge von Wegspülung, fast gänzlich.

Eine nähere Beschreibung der dortigen Lagerungsverhältnisse, welche GOMES wieder gibt, rührt gleichfalls von CARLOS RIBEIRA her, welchem man auch die specielleren Mittheilungen über die anderen Kohlenreviere verdankt.

Die von GOMES beschriebenen Pflanzen sind folgende:

Classis Cryptogamae vasculares.

Ordo Calamariae.

Fam. Calamiteae ENDL.

1. *Calamites Suckowi* BGT. — S. Pedro da Cova und Povoa.

(*Calam. decoratus* BGT., den der Verfasser hier erwähnt, unterscheidet sich von *C. Suckowi* durch seine Knoten nicht nur am oberen Ende, sondern auch am unteren Ende der

Rippen. Die Abbildungen von BRONGNIART, Vég. foss. I, Pl. 14, f. 1—5, sind verkehrt gestellt. Diese Art scheint der Dyas anzugehören, wenigstens kommt sie ausgezeichnet in einem hierzu gehörigen Sandsteine von Niederwörresbach im Birkenfeld'schen vor. — Unsere Ansicht über *Calamites communis* ERR. s. Jb. 1866, 766.)

2. *Cal. undulatus* ST. — S. Pedro da Cova.
(Gehört zu *C. cannaeformis* SCHL.)
3. *Cal. cannaeformis* SCHL., BGT. — S. Pedro da Cova bei Ervedoza.
4. *Cal. Cisti* BGT. — S. Pedro da Cova bei Ervedoza und Montalto.
5. *Cal. gigas* BGT. — S. Pedro da Cova.

(Man hat diese Art bisher nur in der unteren Dyas aufgefunden.)

Fam. *Asterophyllitae*.

6. *Volkmannia gracilis* ST. — S. Pedro da Cova, Povoá, Ervedoza, Montalto.

(Diess ist ein *Asterophyllites*, wie sich aus den hervortretenden Gelenkringen ergibt, zunächst an *A. grandis* ST. sp. sich anschliessend.)

7. *Asterophyllites tuberculata* GOMES, p. 4, Taf. IV, f. 1, — von S. Pedro da Cova — stellt die Fruchtabre eines *Asterophyllites* oder einer *Annularia* dar, deren Abstammung nicht ganz sicher ist. Die citirte Abbildung bei LINDLEY und HUTTON (*Foss. Fl. Pl.* 180) glauben wir, auf *Asterophyllites foliosus* LINDL. zurückführen zu müssen, *Bruckmannia tuberculata* ST. aber ist die Fruchtabre von *Annularia longifolia* BGT. Die Abbildung von GOMES weist vielleicht am nächsten auf *Asterophyllites grandis* ST. sp. oder *Ast. rigidus* ST. sp. hin. (Vgl. GEINITZ, d. Verst. d. Steinkohlenformation in Sachsen, 1855, Taf. XVII.)

8. *Asterophyllites rigida* BGT. — S. Pedro da Cova.
(Richtiger: *Asterophyllites rigidus* ST. sp.)
9. *Asterophyllites tenuifolia* BGT. — Ervedoza und Montalto.
(Die hier citirte *Bruckmannia tenuifolia* ST. gehört zu *Asterophyllites grandis* ST. sp.)
10. *Annularia longifolia* BGT. — Bussaco.

11. *Annularia brevifolia* BGT. — S. Pedro da Cova.
(Wahrscheinlich ist *Ann. sphenophylloides* ZENKER gemeint.)
12. *Beckera dubia* ST. — Pova, Montalto, Vallongo und Bussaco.
(Statt *Beckera dubia* GOMES. Das Exemplar bei STERNBERG gehört wohl zu *Asterophyllites foliosus* LINDL.)
13. *Sphenophyllum Schlotheimi* BGT. — von Bussaco. (= *Sph. emarginatum* BGT.)

Ordo Filices.

14. *Neuropteris cordata* BGT. — Bussaco.
15. *N. Scheuchzeri* HOFFM. — Moinho d'Ordem bei Alcacer, Bussaco.
16. *N. acutifolia* BGT. — Moinho d'Ordem.
17. *N. flexuosa* ST. — S. Pedro da Cova, Villa Verde, Poço Esperança e Farrobo.
18. *N. Loshi* BGT. — Ebendaher.
19. *N. Brongniarti* ST. = *N. heterophylla* BGT. — S. Pedro da Cova.
20. *N. auriculata* BGT. — S. Pedro da Cova, Moinho d'Ordem bei Alcacer.
21. *Cyclopteris dilatata* L. & H. — S. Pedro da Cova.
22. *Odontopteris Brardi* BGT. — Fonte do Salgueiro in Bussaco.
23. *Od. obtusa* BGT. — S. Pedro da Cova, Galeria Thomaz.
(Wird vom Verfasser nur für eine Varietät der vorigen gehalten.)
24. *Sphenopteris cristata* ST. — S. Pedro da Cova.
25. *Sph. chaerophylloides* ST. — Pedorido, Villa Verde, Poço Esperança e Farrobo.
26. *Sphenopteris erosum* LINDL. & HUTT. FOSS. FL. I, p. 41, Pl. 13.
— Von S. Pedro da Cova.
(Ist wohl nur durch Versehen an diese Stelle gekommen und gehört neben No. 13, da *Sphenophyllum erosum* gemeint ist.)
27. *Hymenophyllites Costae* GOMES, p. 13, Taf. V, f. 1, 2. — S. Pedro da Cova.

(Diese Art erinnert sowohl durch die Form ihrer Fiederchen, als auch durch ihre einfachen Seitennerven zu-

- nächst an *Cyatheetes arborescens* und würde, der Abbildung und Beschreibung nach zu schliessen, weit eher hierzu, als zu einem *Hymenophyllites* gehören können.
28. *Diplazites longifolia* Gö. — Bussaco.
29. *Diplaz. emarginata* Gö. — Covêlo.
(Ist mit der vorigen zu vereinen.)
30. *Alethopteris lonchitidis* St. — Fundort unbekannt.
31. *Al. Dournaisi* Bgt. sp. — Ervedoza und Montalto.
32. *Al. Grandini* Bgt. sp. — Covêlo, Ervedoza, Passal, Montalto, Valle do Deão.
33. *Al. urophylla* Bgt. sp. — Montalto und Vallongo.
34. *Al. muricata* Gö. — S. Pedro da Cova, Pedorido.
(Würde wohl richtiger als *Sphenopteris muricata* SCHL. sp. zu bezeichnen sein.)
35. *Al. Bucklandi* Bgt. sp. — S. Pedro da Cova.
36. *Al. Brongniarti* Göpp. = *Al. pteroides* Bgt. sp. — S. Pedro da Cova.
37. *Cyatheetes Schlotheimi* Gö. — S. Pedro da Cova, Povia, Valverde, Campos do Óuteiro.
(Exemplare mit einfachen Seitennerven gehören zu *C. arborescens* SCHL. sp., die mit dichotomen Seitennerven zu *C. Candolleaneus* Bgt. sp.)
38. *C. arborescens* SCHL. sp. — S. Pedro da Cova, Povia, Valle de Carros, Ervedoza, bei Bussaco, bei Moinho d'Ordem.
39. *C. lepidorhachis* Bgt., Gö. — S. Pedro da Cova.
(Zu *C. Candolleaneus* Bgt. sp.)
40. *C. Oreopteridis* Bgt. sp. = *C. oreopteroides* Gö. — S. Pedro da Cova, Pedorido, bei Bussaco.
41. *C. Miltoni* ARTIS sp., Gö. — S. Pedro da Cova, Pedorido.
42. *Hemitelites gigantea* Bgt. sp., Gö. — S. Pedro da Cova, Valle de Carros, Ervedoza, Montalto, bei Bussaco.
(*Pecopteris gigantea* und *Pec. punctulata* Bgt. werden wahrscheinlich von *Cyatheetes confertus* St. sp. aufgenommen. Diese Art gehört vorzugsweise der unteren Dyas an.)
43. *Polypodites elegans* Gö. — S. Pedro da Cova — (= *Cyatheetes argutus* Bgt. sp., welche Art nach BUNBURY auch bei Bussaco vorkommt.)

44. *Aspidites Pluckeneti* Gö. — S. Pedro da Cova, Paçal, Poço Carlota. —

(= *Alethopteris Pluckeneti* SCHL. sp.)

45. *Pecopteris leptophylla* BUNB. (*Quart. Journ. of the Geol. Soc. of London*, Vol. 9, p. 144, Pl. 7, f. 11, GOMES, p. 22, Tab. III, f. 2, 3. — Bei Bussaco und bei S. Pedro da Cova.

(Diese Art mag vielmehr zu *Sphenopteris* oder *Hymenophyllites* gehören, wofür auch die Bemerkung von GOMES spricht: »*Pinnulis fructificantibus sori inferiorem frondis paginam omnino obtegentes*«.)

46. *Pec. plumosa* BGT. — S. Pedro da Cova.

(= *Cyatheites plumosus* ARTIS sp.)

47. *Pec. delicatula* BGT. — S. Pedro da Cova, Ervedoza, Montalto.

(= *Cyatheites delicatulus* BGT. sp., welche Art trotz ihrer nahen Verwandtschaft mit *C. plumosus* dennoch davon abgetrennt bleiben mag.)

48. *Pec. obliqua* BGT. — S. Pedro da Cova, Ervedoza, Montalto, bei Bussaco.

(Wahrscheinlich zu *Alethopteris* gehörig.)

49. *Pec. unita* BGT. = *Cyatheites unitus* BGT. sp. — Pedorido.

50. *Pec. lanceolata* ST. — S. Pedro da Cova, Passal, Pedorido.

(Wie *Hymenophyllites Costae* GOMES vielleicht nur eine Varietät des *Cyatheites arborescens*.)

51. *Pec. abbreviata* BGT. S. Pedro da Cova.

(Diese Art ist mit *Cyath. Miltoni* BGT. sp. zu vereinen, wozu auch *Pec. sp.* GOMES Tab. III, f. 1 gehören dürfte.)

Ordo Selagines.

52. *Stigmaria fcooides* BGT. — S. Pedro da Cova.

(Das Vorkommen der *Var. vulgaris*, welche, zum Theil wenigstens, eine selbstständige Pflanze ist, gewinnt bei dem Mangel an Sigillarien Wahrscheinlichkeit. *Var. inaequalis* Gö., welche GOMES gleichfalls dort gefunden hat, kann auf eine *Sagenaria* zurückgeführt werden, wenn auch nicht auf *Sag. Veltheimiana* ST. sp., mit welcher sie in anderen Ländern oft zusammen vorkommt und als deren Wurzel man sie dann betrachten kann. In einer ganz ähnlichen Stig-

marienform tritt die Wurzel der *Sag. dichotoma* auf. Sie ist die als *Stigmaria ficoides* Var. *minor* GEIN. bezeichnete Form.)

53. *Sagenaria aculeata* St. sp., PRESL. — S. Pedro da Cova.

54. *Sag. obovata* St. — Montalto.

55. *Knorria imbricata* St. — S. Pedro da Cova.

(Wäre die Bestimmung der drei letzten Arten vollkommen sicher, so würde dadurch ein Beweis für ein höheres Alter wenigstens einiger Schichten von S. Pedro da Cova geboten worden sein, da diese beiden *Sagenaria* in den älteren Zonen der Steinkohlenformation, *Knorria imbricata* aber nur in der ältesten Zone derselben mit *Sagenaria Veltheimiana* und *Calamites transitionis* GÖ. zusammen auftritt. Von beiden letztgenannten Arten ist jedoch aus diesen Gegenden noch nichts bekannt geworden.)

56. *Lycopodites piniformis* BGT. — Bei Bussaco.

(= *Walchia piniformis* SCHL. sp.)

57. *Lycopodites affinis* BGT. — Valle do Leão.

(= *Walchia fliciformis* SCHL. sp. — Bestätiget sich das Vorkommen dieser zwei *Walchien*, so weist diess auf das Vorhandensein der unteren Dyas oder wenigstens der obersten Zonen der Steinkohlenformation hin.)

Plantae monocotyledoneae.

Ordo Palmae.

58. *Cordaites borassifolius* St. sp. — S. Pedro da Cova, Passal, Pedorido, bei Moinho d'Ordem.

(Ob hier *C. borassifolius* oder *C. principalis* GERMAR vorlag, kann nicht entschieden werden, ist aber für die Bestimmung der Zone nicht unwichtig.)

59. *Endogenites striata* L. & H. — Bussaco.

(Diese keinesweges sicher bestimmte Axe eines Stammes bietet uns keinen Anhaltepunkt, trotzdem das selbst noch räthselhafte *Angiodendron orientale* EICHWALD damit vereint worden ist.)

Ordo *Noeggerathieae*.

60. *Noeggerathia* sp. GOMES p. 32, Tab. II, f. 1, 2. — S. Pedro da Cova.

(Darf wohl mit *Asplenites elegans* ETT. vereinigt werden, welche Art v. GUTBIER zuerst als *Sphenopteris Asplenites* beschrieb. Diese gehört zu den Farren.)

Ordo *Cyperaceae*.

61. ? *Cyperites* sp. GOMES, p. 32, Tab. I, f. 1—3; Taf. V, f. 3. — S. Pedro da Cova.

(Hier tritt uns dieselbe Pflanze entgegen, welche v. ERTINGSHAUSEN in den Abhandl. d. k. k. geol. Reichsanst. Bd. II, Steinkohlenflora von Radnitz pg. 59, Taf. 24, f. 1, 2, als *Flabellaria Sternbergi* von Swina in Böhmen beschrieben hat.)

Fructus.

62. *Trigonocarpon Noeggerathi* BGT. — Vallongo und Pova.
 63. *Carpolithes* sp. GOMES, Taf. IV, f. 2. — Moinho d'Ordem.
 64. *Carpolithes* sp. GOMES, Taf. IV, f. 3. — Moinho d'Ordem.

(Dem *Rhabdocarpus amygdalaeformis* GÖ. & BE., 1848, sehr ähnlich.)

65. *Carpolithes* ? GOMES, Taf. IV, f. 5. — S. Pedro da Cova, Vallongo, Pova.

(Ein sehr grosses Exemplar eines *Cyclocarpon* GÖ. & FIEDLER, 1858.) —

Diese von GOMES unterschiedenen Arten lassen sich, wie gezeigt, auf höchstens 60 zurückführen, da No. 2 (*Cal. undulatus*) zu No. 3 (*Cal. cannaef.*) gehört, No. 7 (*Ast. tuberc.*) mit einer anderen Art zusammenfällt, No. 28 und 29 nur eine Art bilden, No. 37 (*Cyath. Schloth.*) theils zu No. 38 (*Cyath. arbor.*), theils zu No. 39 (*Cyath. Candolleanus*) gehört und No. 51 (*Pec. abbrev.*) mit No. 41 (*Cyath. Miltoni*) identisch ist.

Unter diesen würden, unter Annahme richtiger Bestimmungen, nur No. 55 (*Knorria imbricata*) und vielleicht No. 52 (*Stigmaria* Var. *inaequalis*) auf die älteste Zone der Steinkohlenformation oder die Hauptzone der Lycopodiaceen hinweisen. Beide stammen von S. Pedro da Cova, von wo gleich-

zeitig auch drei in der unteren Dyas beobachtete Formen, wie *Calamites decoratus* Bgr., *Cal. gigas* Bgr. und *Hemitelites gigantea* (No. 42) aufgeführt wurden. Die beiden in der unteren Dyas so verbreiteten Walchien (No. 56 und 57) rühren von anderen Fundorten dar.

Walchia piniformis SCHL. sp., die wir mit Sicherheit auch in unserer vierten Zone oder Hauptzone der Annularien beobachtet haben, ist übrigens leicht mit den jungen beblätterten Zweigen verschiedener Sagenarien und anderer Lycopodiaceen zu verwechseln und man kann ihre Existenz in der Steinkohlenformation meist nur dann mit Sicherheit annehmen, wenn die von ihr abstammenden Fruchtschuppen (GEINITZ, Dyas II, p. 143, Taf. XXIX, f. 5, 6; Taf. XXXI, f. 5—10) gleichzeitig damit zusammen oder in der Nähe jener Zweige gefunden worden sind.

Der schon von BUNBURY erwähnte und auch durch GOMES noch nicht beseitigte Mangel an Sigillarien in den Steinkohlenrevieren von Portugal ist ein negativer Beweis für das Fehlen der zweiten Zone oder der Hauptzone der Sigillarien, wiewohl *Sagenaria aculeata* und *Sag. obovata* (No. 53 und 54) gerade diesen Horizont lieben.

GOMES ist selbst zu der Ansicht gelangt, dass die fossilen Floren von den drei hier behandelten Steinkohlenrevieren im Allgemeinen keine so wesentlichen Unterschiede darbieten, dass man eine Trennung derselben in verschiedene Zonen vornehmen könne, dass sie aber von der Flora der älteren Steinkohlen, oder der Hauptzone der Lycopodiaceen, wesentlich verschieden sei. Darin müssen wir ihm vollkommen beistimmen, indem wir zugleich eine neue Prüfung der als *Knorria imbricata* bezeichneten Form anrathen.

Wenn man ferner nach den gegenwärtigen Aufschlüssen auch die zweite Zone, die Hauptzone der Sigillarien, dort vermisst, so wird man auf eine der jüngeren Zonen der Steinkohlenformation verwiesen, die wir schon früher als dritte, vierte und fünfte Zone, oder Hauptzone der Calamiten, der Annularien und der Farne unterschieden haben*.

* 1855, die Versteinerungen der Steinkohlenformation in Sachsen. — 1856, Geogn. Darst. d. Steinkohlenformation in Sachsen. — 1865, die Steinkohlen Deutschlands und anderer Länder Europa's I.

Unter diesen erscheint die Hauptzone der Calamiten von einer weit localeren Verbreitung als die ihr nachfolgenden Zonen, vielleicht desshalb, weil in ihre Bildungszeit die Entstehung von mehreren älteren Porphyren gefallen ist, was sich insbesondere aus den Untersuchungen in Sachsen herausgestellt hat. Nach ihrem petrographischen Charakter unterscheiden sich die Steinkohlenflötze dieser Zone durch das Vorherrschen einer ganz vorzugsweise aus Calamiten gebildeten Russ- oder Faserkohle, womit die uns bekannte Beschaffenheit der portugiesischen Steinkohlen keinesweges übereinstimmt. Pechkohlenstreifen in den Russkohlenflötzen rühren in Sachsen meist von Sigillarien und Lycopodiaceen her, welche in dieser Zone nicht selten sind.

Man erkennt wohl, wie unter diesen Verhältnissen die jenen Steinkohlenlagern angewiesene Stellung in die Hauptzone der Annularien naturgemäss war, da auch die von GOMES beschriebenen Pflanzen zum grössten Theile auf eine der oberen Zonen hinweisen. Dem Umstande aber, dass einige unter diesen sind, welche man mehr in der zweiten und dritten Zone anzutreffen pflegt, während andere wiederum nur an die vierte oder fünfte Zone gebunden sind und sogar in die Dyas reichen, ist dadurch Rechnung getragen worden, dass wir gerade die Annularienzone und nicht die Hauptzone der Farne als die richtige Stufe betrachten, welcher auch die anthracitischen Kohlenlager von Sardinien, Insel Corsica und Jano in Toscana, oder die Steinkohlenformation des Plauen'schen Grundes bei Dresden angehören. Während die untere Etage der productiven Steinkohlenformation, die an Sigillarien reiche, mit der Bildung der Calamitenzone geschlossen hat, wofern deren Entwicklung nicht durch die Entstehung plutonischer Gesteine verhindert oder gestört worden ist, hat die obere Etage der productiven Steinkohlenformation mit der Annularienzone begonnen und mag allmählich in die Farnzone verlaufen sein.

Unsere gesammten Untersuchungen im Gebiete der Steinkohlenformation führen uns immer und immer wieder zu dieser Gliederung hin:

Ältere Steinkohlenformation.	I. Hauptzone der Lycopodiaceen.
Untere Etage der productiven Steinkohlen-Formation oder mittlere Steinkohlen-Formation.	II. Hauptzone der Sigillarien.
Obere Etage der productiven Steinkohlen-Formation oder obere Steinkohlen-Formation.	III. Hauptzone der Calamiten.
	IV. Hauptzone der Annularien.
	V. Hauptzoe der Farne.
Untere Dyas.	VI. Hauptzone der Walchien.

2. Über organische Überreste aus der Steinkohlengrube Arnao bei Avilés in Asturien.

Taf. III, Fig. 1, 2.

Noch weit geringer, als von Portugal, ist die bisherige Kenntniss der organischen Überreste in der Steinkohlenformation von Spanien geblieben, wenn man auch so viel Anhaltspunkte schon gewonnen hat, dass man die Schwarzkohlenlager im nördlichen Spanien an den beiden Abhängen der Cantelabrischen Gebirgskette, ebenso wie die Kohlenmulde von Belmez und Espiel und jene von Villa nueva del Rio in der Provinz Sevilla, der productiven Steinkohlenformation und zwar zumeist deren Sigillarienzonen zuweisen konnte. (Vgl. GEINITZ, FLECK und HARTIG, die Steinkohlen Deutschlands und and. Länder Europa's, 1865, I, p. 344—348 und p. 406.) Schon desshalb war es für uns eine grosse Freude, durch den uns befreundeten Director der *Real Compañía Asturiana* in Avilés, Asturien, Herrn MARTIN FLATHE, eine Sendung von Steinkohlenpflanzen und anderen Fossilien aus der dieser Compagnie gehörenden Grube Arnao bei Avilés zu erhalten, worüber wir hier berichten.

Die dort vorherrschende Steinkohle schliesst sich eng an die Pechkohle an und entspricht am meisten den Sigillarienkohlen. Dr. H. FLECK fand ihr specifisches Gewicht = 1,357.

Über ihr chemisches Verhalten soll an einem anderen Orte berichtet werden.

Ausserdem waren eine Probe von Faserkohle und ein paar

Stücke verkockte Kohle beigelegt, welche letztere durch einen Grubenbrand entstanden war.

Pflanzenreste sind in dem Kohlengebirge hier ziemlich selten, doch liessen sich in dieser Sendung unterscheiden:

1. *Calamites cannaeformis* SCHL., sowohl im Schieferthon als auch im Kohlensandsteine,
2. *Calamites Suckowi* BGT. im grauen Schieferthone,
3. *Neuropteris gigantea* ? ST. dessgl.,
4. *Odontopteris Brardi* BGT. dessgl.,
5. *Cyatheites dentatus* BGT. im Schieferthone und im Sandsteine,
6. *Alethopteris Pluckeneti* SCHL. sp. im Schieferthone,
7. *Cordailes borassifolius* ST. sp. Blätter und Axe des Stammes (*Artisia approximata* = *Sternbergia* app. LINDL. & HUTT.),
8. *Sigillaria Brardi* BGT., in mehreren sehr deutlichen Exemplaren auf einem sandigen Schieferthone.
9. *Sigillaria cyclostigma* BGT. & GEIN.,
10. *Sigillaria Knorri* ? BGT.,
11. *Sigillaria Dournaisi* ? BGT. und
12. *Sigillaria mamillaris* ? BGT.,

welche drei letzteren wegen ihrer Undeutlichkeit keine vollkommen sichere Bestimmung zugelassen haben. Doch beweisen diese Pflanzen von neuem, dass die Flötze der Grube Arnao der Sigillarienzonen angehören.

Gleichzeitig übersandte Herr FLATHE zwei Crinoideen-Kelche aus einem kalkigen Rotheisensteine, der in dem westlichen Theile des Grubenfeldes Arnao, wahrscheinlich in Folge einer Überkipfung, über der Kohle liegt. Zur Bestimmung des Alters dieser Schicht wird uns kein weiterer Anhaltspunct gegeben, doch gehört sie wahrscheinlich der Carbonformation an.

Das Bemühen, diesen Crinoiden auf eine schon bekannte Form zurückzuführen, war ein vergebliches und wir müssen ihn selbst zum Typus einer neuen Gattung erheben:

Trybliocrinus GEIN.

Taf. III, Fig. 1, 2. — (τρυβλίον, Schale, Becher: κρίνος, Lilie.)

Die Form dieses Crinoiden-Kelches entspricht einer Schale

oder einem niedrigen Becher mit einer ebenen oder flach-concaven, breiten Grundfläche. Das letzte Stück der verhältnissmässig dicken, rundlichen Säule, das von den Tafeln des Kelches scharf begrenzt wird, senkt sich fast trichterförmig in den Kelch hinein und lässt auf seiner Gelenkfläche eine feine radiale Streifung wahrnehmen. Daran stösst unmittelbar ein aus 10—12 ungleichen Gliedern bestehender Ring, in welchem neben fünf ungleichen Basalstücken auch die Kelchradien unmittelbar ihren Anfang nehmen. Die letzteren sind in der Abbildung durch punctirte Linien hervorgehoben. — Dieser Charakter nähert unsere Gattung dem *Cleioocrinus* BILLINGS (*Geol. Surv. of Canada*, Dec. IV, 1859, p. 52 u. f.), doch ist sie weit unregelmässiger und complicirter gebauet, als diese, durch das Vorhandensein zahlreicher Interradialstücke sowohl zwischen den Kelchradien, wodurch sie den Gattungen *Rhodocrinus* MILLER und *Glyptocrinus* HALL genähert wird, als auch durch Zwischentafeln in der Richtung der Kelchradien selbst, welche sich zwischen die Hauptreihen eindrängen und den Kelch sehr erweitern. —

Jeder Kelchradius besteht aus 2—3 Stücken. Die mit a und c bezeichneten besitzen deren nur 2, von denen das erstere, kleinere fast vierseitig, das zweite, grössere 5—6seitig ist und als Axillarglied gilt. An dem mit b unterschiedenen Kelchradius liegen 3 Tafeln in einer Reihe, unter welchen die erste sehr niedrig ist, die zweite ein regelmässiges Sechseck, die dritte aber ein regelmässig-fünfeitiges Axillarglied bildet. Die Kelchradien e und d bestehen zwar auch aus drei Tafeln, doch in einer anderen Ordnung, indem je 2 untere, neben einander gelegene für nur ein Stück der anderen Kelchradien eintreten, woran sich ein sechsseitiges Axillarglied schliesst.

Es sind demnach 7, statt fünf, in ihrer Form und Grösse sehr ungleiche Stücke vorhanden, mit welchen die fünf Kelchradien beginnen und welche mit den 5 ebenso ungleichen Basalstücken den untersten Ring an der Basis des Kelches zusammensetzen.

An ein jedes Axillarglied der 5 Kelchradien reihet sich nach oben hin jederseits eine 6seitige Tafel an, welche den Anfang von 2 divergirenden Hauptreihen bildet, die aber durch ähnlich gestaltete Zwischentafeln in der Richtung der Kelchradien und

andere, an letztere grenzende Tafeln von einander geschieden werden. Die Abnahme in der Grösse der Tafeln erfolgt nach oben hin in einer ganz ähnlichen Weise, wie bei *Cleiocrinus*, was aus der Seitenansicht Fig. 2 hervorgeht.

Als Interradialstücke wird man alle die ziemlich unregelmässig gestalteten und vertheilten grösseren Tafeln bezeichnen müssen, welche sich zwischen den durch eine punctirte Linie bezeichneten Kelchradien und den Basalstücken einerseits und jenen von dem ersten Axillargliede des Kelchradius aus nach beiden Seiten hin divergirenden Tafelreihen anderseits ausbreiten.

Unsere Abbildung lässt von denselben zwischen je zwei Kelchradien 5—6 wahrnehmen, wie diess in ähnlicher Weise auch bei *Rhodocrinus* und *Glyptocrinus* der Fall ist, denen wahrscheinlich nach oben hin noch eine weit grössere Anzahl von kleinen Tafeln folgt.

Gl. Flatheanus GEIN.

Taf. III, Fig. 1, 2.

Die einzige bis jetzt bekannte Art dieser Gattung erreicht die doppelte Grösse des hier abgebildeten Exemplars und zeichnet sich durch eine fast glatte Beschaffenheit sämmtlicher unteren, grösseren Kelchtafeln aus, dagegen nehmen die oberen, kleineren Tafeln eine höckerige Beschaffenheit an. — Das obere Ende des Fossils ist nicht deutlich erhalten. — An dem grösseren Exemplare erscheinen die Tafeln etwas flacher und glatter als an dem kleineren.

Auf einem der beiden uns vorliegenden Exemplare ist eine der überrindenden Varietät von *Stenopora columnaris* SCHL. ähnliche Koralle befestiget.

3. Über *Dictyophyton* ? *Liebeanum* GEIN. aus dem Culmschiefer vom Heersberge zwischen Gera und Weyda.

Taf. III, Fig. 3.

Die Bemerkungen von J. HALL über die Gattungen *Uphantænia* und *Dictyophyton* in dem 16. Jahresberichte über das „State Cabinet of Natural History“ in dem Staate New-York, Albany, 1863, p. 84—91, haben eine Reihe fossiler Überreste aus der zum oberen Devon gehörenden Chemung-Gruppe zur

Anschauung gebracht, welche von HALL zu den Algen gestellt worden sind. Unter diesen ist *Uphantaenia Chemungensis* VANUXEM, die einzige Art dieser Gattung, in folgender Weise bezeichnet:

Uphantaenia VANUXEM.

Ein kreis- oder fächerförmiger Körper, der aus zungenförmig ausstrahlenden und bandförmigen concentrischen Streifen zusammengesetzt ist, wodurch in seiner Substanz eine netzförmige Anordnung entsteht, welche nicht nur durch eine oberflächliche Streifung hervorgebracht ist.

Für die durch ihre Textur mit *Uphantaenia* nahe verwandten Körper, die sich jedoch hiervon meist durch eine verkehrt-kegelförmige oder fast cylindrische Gestalt unterscheiden, ist der Gattungsname *Dictyophyton* in Vorschlag gebracht worden.

Dictyophyton HALL.

Fächer- oder trichterförmige Körper mit einem umgekehrt-kegelförmigen oder cylindrischen hohlen Stengel und mit zahlreichen, sich durchkreuzenden Streifen bedeckt, durch welche die Oberfläche in kleine, rechtwinkelige, vertiefte Zwischenräume zerfällt.

Bei einigen Arten heben sich unter den ausstrahlenden Streifen mehrere rippenartig hervor, welche theils in regelmässigen, theils in unregelmässigen Entfernungen feinere Streifen einschliessen. Durch wiederholte Einschnürung des Stengels bei einigen Arten schwellen die stärkeren Streifen zu schmalen oder länglichen Höckern an.

Die von J. HALL unterschiedenen Arten sind:

D. Newberryi HALL, *D. filitextile* HALL, *D. Redfieldi* HALL, *D. Conradi* HALL, *D. rude* HALL, *D. fenestratum* HALL, *D. annulatum* HALL, *D. tuberosum* HALL (= *Hydnoceras tuberosum* CONRAD) und *D. nodosum* HALL.

Unter diesen ist *D. tuberosum* HALL von DAWSON (*Quart. Journ. of the Geol. Soc. of London*, Vol. XVIII, p. 325, Pl. 17, f. 62) mit *Uphantaenia Chemungensis* VAN. vereinigt worden.

Wir möchten diesen Arten, wenn auch nicht ohne einiges Bedenken, eine neue hinzufügen, deren geologischer Horizont von jenem der Chemung-Gruppe nicht sehr entfernt liegt:

Dictyophyton Liebeanum GEIN.

Diese Art bildet, wohl nur in Folge der Zusammendrückung, flache, fächerartige Ausbreitungen, welche von eng aneinander liegenden, ziemlich gleich starken, ausstrahlenden Streifen bedeckt wird, die sich zu unregelmässigen, wellenförmigen, flachen Falten gruppieren. Diese Streifen werden von entferntliegenden, etwas wellenförmigen Streifen, förmlichen Anwachsstreifen, durchkreuzt, welche verbieten, diesen Organismus, trotz ihrer übrigen Ähnlichkeit, mit *Noeggerathia* zu vereinen.

Die Dicke, der in Stein umgewandelten Substanz des Fossils beträgt noch nicht 1^{mm}.

Unsere Abbildung in der wirklichen Grösse lässt erkennen, dass sowohl die ausstrahlenden, als auch die jene durchkreuzenden Streifen auf beiden gegenüber liegenden Flächen des Fossils gleich gut bemerkbar sind. Der mit a unterschiedene Theil zeigt die eine, der mit b bezeichnete den Abdruck der anderen Fläche.

Vorkommen: Diese Art ist von Herrn Professor Dr. LIEBE in Gera in einem zu dem Culm oder der älteren Kohlenformation gehörenden Grauwackenschiefer des Heersberges zwischen Gera und Weyda aufgefunden worden, wo auch *Calamites transitionis* GÖPP. vorkommt.

4. Über ? *Trigonocarpus Roessleri* GEIN.

Taf. III, Fig. 4.

Von *Trigonocarpus* (*Trigonocarpon*) *Roessleri* GEIN. (Dyas, II, 1861—62, p. 147, Taf. 34, f. 1) ist bisher nur ein einziges Exemplar aus der unteren Dyas an der Naumburg in der Wetterau beschrieben worden, das jedoch scharf genug ausgeprägt schien, um eine neue Art darauf zu begründen. Diese ist von anderen Arten dieser Gattung durch ihre 12 von dem Scheitel nach der Basis strahlenden Längsrippen unterschieden.

Durch die Güte des Herrn Bergmeister SCHÜTZE, Director der Bergschule in Waldenburg, wurde mir das Taf. III, Fig. 4 abgebildete Fossil zur Bestimmung anvertraut, in welchem vielleicht der Jugendzustand dieser Frucht vorliegt.

Von einem gestreiften Stengel gehen, an dem vorliegenden

Exemplare nur nach einer Seite hin, kurze, abstechende Zweige aus, an denen sich wenige, gegen 3, kurzgestielte Früchte befestigen. Diese erscheinen, wahrscheinlich durch Zusammenrückung, flach schildförmig oder scheibenförmig, in kreisrund-elliptischer Form und von etwa 5^{mm} Durchmesser.

Wo diese Körper von der verkohlten Substanz der Frucht noch bedeckt sind, ist ihre Oberfläche rau, insbesondere an dem mit b bezeichneten Individuum, das noch von der Fruchthülle bedeckt zu sein scheint, und zum Theil ausstrahlend gefaltet, wo aber verkohlte Fruchtsubstanz fehlt, unterscheidet man sehr deutlich 12 regelmässig angeordnete, ausstrahlende Linien, welche die flach vertiefte und an ihrem Rande meist wulstförmig erhobene Scheibe in 12 keilförmige Stücke zertrennen. (Vgl. die Vergrößerung A von Fig. 4 a). Diese Linien würden den schmalen Längsrippen der Aussenseite entsprechen, welche für diese Frucht bezeichnend sind.

Man hätte es offenbar hier nur mit dem noch weichen Jugendzustande dieser Früchte zu thun, an welchem die Längsrippen noch eine zartere Beschaffenheit besaßen, als an dem älteren, aus der Wetterau abgebildeten Exemplare. Auch die dünne verkohlte Substanz, welche diese Körper bedeckt, weist darauf hin.

Mit dieser Deutung des noch räthselhaften Fossils würde nach unseren bisherigen Erfahrungen über die geologische Vertheilung fossiler Pflanzen die Annahme einer Cycadeen-artigen Form in der unteren Dyas weit mehr übereinstimmen, als die Herbeiziehung einer anderen Pflanzenfamilie, deren Formen theilweise noch grössere Ähnlichkeit hiermit zeigen, als gerade *Trigonocarpus Roessleri*. —

Wenn man von *Annularia sphenophylloides* ZENKER, deren Wirtel diesen Früchten nicht unähnlich sind, deshalb gänzlich absehen muss, da an dem Stengel unseres Fossils keine Spur einer Gliederung wahrzunehmen ist, so würden etwa die Früchte von *Malva*, von *Phytolacca* und von *Hura crepitans* L., bei ihrer scheibenförmigen und vielfächerigen Beschaffenheit, in einer ähnlichen Gestalt erscheinen. Gegen eine jede dieser Gattungen lassen sich jedoch nicht nur von geologischer, sondern auch von botanischer Seite aus sehr gerechte Bedenken erheben, wie der Mangel des Kelches, von welchem an den beiden obersten Exem-

plaren eine Andeutung wenigstens zu finden sein müsste, die Insertion der Fruchtzweige, ein anderes Zahlengesetz in der Einteilung ihrer Früchte u. s. w.

Ebenso gewagt erscheint es aber auch, diess Fossil mit den Früchten der zu den Tiliaceen gehörenden Gattung *Apeibopsis* HEER (*Flora tert. Helvetiae* III, 1859, p. 37, Taf. CXVIII und CLIV) in Beziehung zu bringen, wiewohl hiermit eine unverkennbare Ähnlichkeit vorhanden ist.

Wahrscheinlicher würde noch die Annahme sein, dass man in vorliegenden Körpern mit gar keiner Frucht, sondern nur mit einer kelchartigen Fruchthülle zu thun habe, wie sie bei *Guillemia* und einigen anderen Palmen gefunden wird.

Muss demnach eine sichere Entscheidung über die Verwandtschaft dieses Fossils noch der Zukunft offen gelassen werden, so haben wir doch nicht länger anstehen wollen, die Aufmerksamkeit darauf zu richten, da man hoffen darf, dass der es noch bedeckende Schleier um so eher gelüftet werde.

Vorkommen: Mit *Walchia piniformis* SCHL. sp. und *Odontopteris obtusiloba* NAUM. zusammen in einem zur unteren Dyas gehörenden, bräunlich-grauen Schieferthone vom Ölberge bei Braunau, dem berühmten Fundorte des *Palaeosiren Beinerti* GEIN. (Jb. 1864, p. 513) und vieler anderer von GÖPPERT beschriebenen Arten.

Fig. 1.

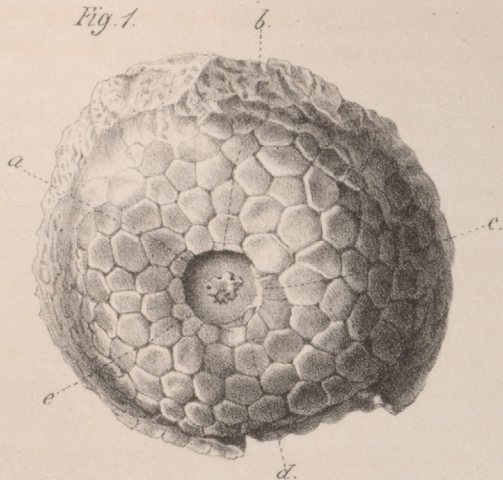


Fig. 2.

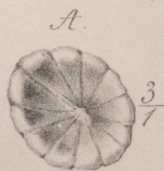


Fig. 3.

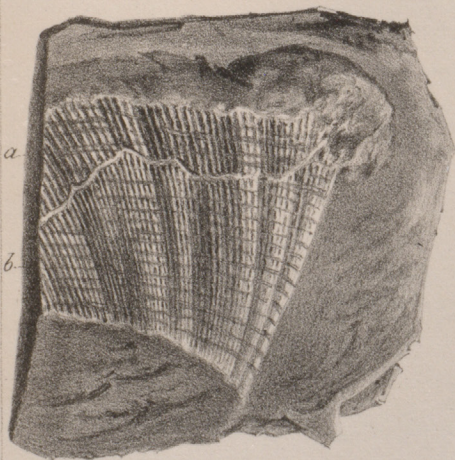


Fig. 4.



Alluvium.	1.	Alluvium. — Silt.
	2.	Kalktuff.
	3.	Torf.
Diluvium.	4.	Löss.
	5.	Schotter. — Gerölle, Terrassen-Diluvium u. s. w.
Neogen.	Süßwasserstufe.	6. Süßwasserkalk.
		7. Congerenschichten. — Congerien-Tegel, Lignit.
		8. Basalttuff. — Wacke im Braunkohlensandstein.
	Brackische Stufe.	9. Cerithien-Schichten. — Cerithien-Sandstein.
		10. Hernalser Tegel. — Schwefel von Swoszowice.
		11. Trachyttuff.
	Marine Stufe.	12. Leithakalk. — Nulliporenkalk, Loretto-Geschiebe, Leithasandstein, Bryozoensandstein.
		13. Mariner Tegel und Sand. — Steinsalz von Bochnia und Wieliczka. Süßwasser-Schichten mit Pechglanzkohle von Elbiswald in Steiermark.
Eocän.	14.	Oberes Eocän. — Flysch, Tassello von Triest, Kohlenschiefer von Zovencedo, Roncathal bei Venedig.
	15.	Unteres Eocän. — Nummulitenkalk.
	16.	Cosina-Schichten in Istrien.
Kreideformation.	17.	Gosaufornation. — Actaeonellen-Schichten, Orbitulitenfels.
	18.	Pläner. — Plänermergel von Kosteletz.
	19.	Quader. — Quadersandstein.
	20.	Karpathen-Sandstein. — Wiener Sandstein mit <i>Chondrites intricatus</i> STB.
	21.	Gault.
	22.	Caprotinenkalk, Spatangenkalk am Karst, Wernsdorfer Schiefer mit <i>Scaphites Ivani</i> PUZOS.
Jura.	23.	Rosfelder Schichten. — Schiefer mit <i>Ammonites cryptoceras</i> und <i>A. Astierianus</i> D'ORB.
	24.	Ober-Jura. — <i>Diceras</i> -Schichten, Plassenkalk mit Nerineen, jurassischer Aptychenkalk, Klippenkalk.
	25.	Unter-Jura. — Vilser Kalk von Windischgarsten, Klauskalk von Swinitza.
Lias.	26.	Ober-Lias. — Posidonienschiefer, Fleckenmergel am Nordfuss des Traunsteins, Adnether (Krinoiden-) Kalk, Enzesfelder Kalk, Grestener Kalk mit <i>Rhynchonella austriaca</i> Süss von Grossau.
	27.	Unter-Lias. — Hierlatzkalk von Hallstatt, Kohlen am Pechgraben, bei Fünfkirchen in Ungarn und Steierdorf im Banat.
Trias.	Rhätische Formation.	28. Dachsteinkalk und Kössener Schichten. — Lithodendronkalk, Ger-villienschichten, Dachsteinkalk.
		29. Hauptdolomit.
		30. Raibler Schichten. — Lunzer Schichten mit Keuperkohle, Wenger Schiefer, Muschelmarmor von Hall.
		31. Hallstätter Kalk und Esino.
		32. St. Cassian-Schichten.
		33. Virgloriakalk von Recoarco.
		34. Guttensteiner Kalk.
		35. Werfener Schichten mit Anhydrit, Steinsalz von Aussee und Gyps.

Dyas. (Permisch.)	36.	Rothliegendes. — Arkosensandstein, kupferführender Brandschiefer (fälschlich Kupferschiefer genannt).
Carbon- For- mation.	37. 38. 39.	Steinkohlenschiefer und Steinkohlen. Culm. — Sandstein und Schiefer mit <i>Calamites transitionis</i> G8. Kohlenkalk in den Alpen. — Gailthaler Schichten.
Grauwacken-Formation,	devonische.	40. Devonischer Kalk.
		41. Devonischer Schiefer.
		42. Ältere rothe Sandsteine von Zaleszezyky in Galizien.
	silurische.	43. Ober-Silur. — Braniker, Konépruser, Kuhlbader, Littener Schichten. (Et. G, F, E von BARRANDE.)
		44. Unter-Silur. — Zahorzaner, Brda, Rokitzaner, Komoraner, Krusnähora- und Ginecer Schichten. Et. D und C von BARRANDE.)
		45. Przibramer Grauwacke.
		46. Przibramer Grauwackenschiefer. — Kieselschiefer, Porphyr von Neu-Joachimsthal, Aphanit, Grauwacke in den Alpen von St. Johann etc.
Krystallinische Schiefergesteine.	47.	Urthonschiefer.
	48.	Talk- und Chloritschiefer.
	49.	Hornblendeschiefer.
	50.	Körniger Kalk und Kalkglimmerschiefer.
	51.	Glimmerschiefer. — Magneteisenerz von Pressnitz, grauer und rother Gneiss, Granulit.
	52.	Serpentin.
Eruptive Gesteine.	53.	Basalt und Dolerit.
	54.	Phonolith.
	55.	Trachyt und Rhyolith. — Lithophysen, Dacit, Teschinit.
	56.	Augitporphyr und Melaphyr.
	57.	Quarzporphyr.
	58.	Grünstein und Diorit.
Massen- Gesteine.	59.	Granit.
	60.	Centralgneiss und Greisen.
	61.	Syenit.

A. v. KOENEN: über einige Aufschlüsse im Diluvium südlich und östlich von Berlin. (Zeitschr. d. deutsch. geol. Ges. 1866, 8 S.) — Wie diess schon BERENDT in seiner gründlichen Arbeit über die Diluvial-Ablagerungen der Mark Brandenburg (Jb. 1864, 96) besonders für die Gegend von Potsdam dargethan hat, so finden sich auch O. und S. von Berlin im Diluvium drei Thonschichten, welche durch Sandschichten getrennt sind und noch über einer mächtigen Schicht sehr feinen Sandes liegen.

Die untere Thonschicht, der geschiebefreie oder Glindower „Diluvial-Thon“, ist blaugrau bis schwarz, meist frei von allen Geschieben, und führt nur selten kleine Kreide- und Feuersteinbrocken. Die beiden oberen, meist sehr sandigen und Geschiebe enthaltenden Thonschichten, den unteren und oberen Sandmergel BERENDT's, führt v. KOENEN als unteren und oberen Ge-

schiebethon an, da diese Namen älter sind und ihm bezeichnender erscheinen.

Der Decksand, welchen BERENDT als oberstes Glied zum Diluvium rechnet, gehört nach BEYRICH und v. KOENEN dem Alluvium an und verdankt seine Ablagerung derselben Zeit und denselben Agentien wie der Wiesenthon.

Der ganz feine, plastische Sand, den BERENDT mit dem Namen Schlagg bezeichnet, wird S. und O. von Berlin allgemein Schluff genannt.

Nach diesen Vorbemerkungen gibt v. KOENEN eine Reihe von ihm mit Sorgfalt beobachteter Profile von Diluvialschichten, die bei dem Baue der neuen Eisenbahnlinsen von Berlin nach Cüstrin und nach Görlitz durch betreffende Erdarbeiten im Frühjahr 1865 aufgedeckt worden sind.

Interessant ist es hierbei, zu hören, dass der obere Geschiebethon an keinem der vom Verfasser erwähnten Punkte eine schwärzliche Farbe hat, wohl aber der untere, besonders wo er vor Einwirkung der Atmosphären geschützt ist; aber auch sonst hat dieser meist eine graubraune, jener eine mehr röthlichbraune Farbe, wodurch eine Analogie mit dem französischen *Diluvium rouge* (oder *D. des plateaux*) und *Diluvium gris* eintritt. —

In Bezug auf die Frage über das höhere Alter des Menschengeschlechtes scheint man im Diluvium der Mark Brandenburg bisher noch keine Anhaltspunkte gewonnen zu haben, wiewohl man gewiss auch bei diesen Untersuchungen sein Augenmerk hierauf gerichtet haben mag.

v. DECHEN: Mittheilung eines Aufsatzes von H. LASPEYRES über Cäsium und Rubidium in plutonischen Silicatgesteinen der preussischen Rheinprovinz. (Verh. d. naturh. Verh. d. preuss. Rheinl. und Westph. XXII. Jahrg. Corr.-Bl. S. 35—47.) — Die beiden 1861 entdeckten Alkalimetalle, Cäsium und Rubidium, sind in den nächsten 4 Jahren in dem Lepidolith oder Lithionglimmer, in verschiedenen Quell- und Soolwassern oder deren künstlichen und natürlichen (Carnallit in den sog. Abraumalzen) Mutterlaugen, in Drusen-Mineralien (*Pollux*) oder in Vegetabilien, wie in den Salzen der Runkelrübe, im Tabak, im Kaffee und in Weintrauben nachgewiesen worden. Das Rubidium ist von beiden das häufigere und in grösseren Massen vorkommende. Nach Untersuchungen von Dr. H. LASPEYRES im Laboratorium von BUNSEN enthält auch der Melaphyr von Norheim etwa

0,000380% Cäsiumoxyd und

0,000298% Rubidiumoxyd.

Es ist dieser Melaphyr, als erstes Eruptivgestein, in welchem diese Metalle entdeckt und bestimmt worden sind, einer genauen chemischen Analyse unterworfen worden, deren Resultat hier folgt:

Kieselsäure	49,971
Borsäure, Titansäure, Phosphorsäure, Kohlen- säure, Chlor (Brom, Jod), Schwefel noch nicht bestimmt.	
Thonerde	17,009
Eisenoxydul (und z. Th. Eisenoxyd) . . .	7,533
Kalkerde	6,388
Strontian und Baryt	0,063
Mangan und Kupfer	Spuren
Magnesia	7,745
Kali	0,775322
Cäsiumoxyd	0,000380
Rubidiumoxyd	0,000298
Natron und Lithion	5,589
Feuchtigkeit	0,625
Glühverlust	5,081
	100,780.

Das grösste Interesse an diesem Vorkommen der Alkalien im Melaphyr von Norheim ist vorläufig der Geognosie zugefallen, wegen der Beziehungen dieses Gesteins im Speciellen und anderer Melaphyre der Pfalz im Generalen zu den heilkräftigen, weltberühmten Quellen von Münster am Stein und Kreuznach in erster und von Dürkheim in zweiter Linie. Die Sool- und Heilquellen des Bades Kreuznach treten zwischen der Saline Münster am Stein und Kreuznach aus zerklüftetem, rothem, quarzführendem Porphy, der auf genannter Länge die Nahe zwischen steilen hohen Felsen durchschneidet, in der Thalsohle, meist sogar im Flussbette in grösserer Zahl mit 10—25 Grad R. zu Tage. Dieser Porphy bildet ein mächtiges stockartiges Lager in den Schichten des Unter-Rothliegenden (der oberen flötzleeren Schichten des Steinkohlen-Gebirges v. DECHEN's), aber in der Nähe des Ober-Rothliegenden. Die Melaphyre der Pfalz bilden ebenfalls in den Schichten des Unter-Rothliegenden Lager und Gänge und sind fast von gleichem Alter mit dem dortigen Porphy.

Ungefähr eine Viertelstunde unterhalb des Norheimer Melaphyrlagers entspringen die Quellen der Saline Münster am Stein und eine Viertelstunde weiter die der Saline Theodorshall aus weitklüftigem Porphy.

Aus allen über den Charakter dieser Quellen hier mitgetheilten That- sachen dürfte hervorgehen, dass man den Ursprung der geheimnissvollen, technisch und medicinisch wichtigen Sool- und Heilquellen der unteren Nahe in den Melaphyren zu suchen hat, mag vielleicht auch ein Theil des Chlor- oder Chlornatrium-Gehaltes anderen Formationen (etwa dem Roth- liegenden, Kohlen- oder Übergangs-Gebirge) entlehnt seyn; die Heilkraft und den eigenthümlichen Charakter der Quellen, also das, was die Quelle erst zur Heilquelle macht, danken wir dem Melaphyre.

Die öffentliche Bibliothek in Melbourne. Der besonderen Güte von Sir REDMUND BARRY verdanken wir die Zusendung des „*Supplemental Catalogue of the Melbourne Public Library for 1865*“, sowie des „*Catalogue of the Casts, Busts, Reliefs and Illustrations of the School of Design and Ceramic Art*“ in dem Museum für Kunst in der öffentlichen Bibliothek zu Melbourne, 1865.

Das vollendet schöne, grosse Gebäude, ringsum geschmückt mit corinthischen Säulen, welches ausschliesslich den Wissenschaften und der Kunst gewidmet ist, versetzt den Beschauer des Titelblattes dieser Schriften in eine der grösseren Städte Europa's. Es stellt die öffentliche Bibliothek zu Melbourne dar, deren Begründung in die Jahre 1853 und 1854 fällt und deren Reichthum im März 1865 schon über 38,000 Bände betrug. Wer nicht mit englischen Verhältnissen bekannt ist, wird die jährliche Anzahl der Leser in dieser Bibliothek kaum fassen, da sie im Jahre 1864: 179,787, im Jahre 1862 sogar: 202,057 betrug. Welcher Hebel hierin für den Fortschritt der allgemeinen Bildung liegt, darf nicht erwähnt werden.

Recht schön und eigenthümlich ist die Ausstattung dieses wohl geordneten Katalogs, da in demselben 65 Arten in Australien einheimischer Pflanzen, auch in einer dem Botaniker leicht verständlichen Darstellung als zierliche Vignetten benutzt worden sind, deren Namen und Autoren auf einer besonderen Liste verzeichnet sind. Geologie ist darin noch nicht stark vertreten, für manchen der geehrten Collegen vielleicht eine Aufforderung, im Interesse der Wissenschaft zur Minderung dieses Mangels nach Kräften mit beizutragen.

C. Paläontologie.

J. F. BRANDT: Mittheilungen über die Naturgeschichte des Mammuth oder Mamont (*Elephas primigenius*). St. Petersburg, 1866. 8°. 41 S., 1 Taf. —

Als Director des zoologischen und vergleichend-anatomischen Museums der Kais. Academie der Wissenschaften in St. Petersburg, welches besonders durch ihn zu einem hohen wissenschaftlichen Range erhoben worden ist, hat der Akademiker J. F. BRANDT bei diesem Museum ausser dem seit 1831 von ihm eingerichteten vergleichend-anatomischen Museum auch eine Sammlung fossiler Reste von Wirbelthieren begründet. In diesem befindet sich unter anderen neben dem Skelet des Elephanten das des berühmten, an der Lena gefundenen Mammuth, dessen Kopf noch grösstentheils, ebenso wie ein Theil des rechten Vorderfusses, mit Haut überzogen ist. Ein ansehnliches, leider ganz kahles Stück der Haut, welche den Körper des Thieres bekleidete, liegt zu seinen Füssen. Zwei aus dem Hautrest herausgesägte, noch dicht behaarte Stücke finden sich nebst Mähnenhaaren des Mammuth in einem der grossen Wandschränke. Einige mehr oder weniger vollständige Schädel und

zahlreiche Hauer dieses Thieres sieht man in der Nähe seines Skelets. Einer der Mammuth-Schädel, der grösste, bietet einen, in Folge einer dem Zwischenkiefer (vermuthlich durch einen Stoss) beigebrachten Verletzung verkümmerten Hauer als pathologische Merkwürdigkeit. *

Auf Grund dieser und anderer werthvoller Materialien, welche BRANDT für eine Naturgeschichte des Mammuth seit einer langen Reihe von Jahren eifrigst gesammelt hat, ist von demselben eine monographische Arbeit hierüber ausgeführt worden, welche sich nicht allein auf den Bau und die geographische Verbreitung dieses Thieres, sondern auch auf seine Existenzbedingungen und andere biologische und geologische Verhältnisse beziehen soll. Diese wichtige Arbeit ist zwar noch nicht ganz abgeschlossen, doch fühlt sich der Verfasser durch den neuen kostbaren Fund einer Mammuthleiche am Busen des Tas (Jb. 1866, 499) veranlasst, schon jetzt einige Mittheilungen über die Gestalt und Unterscheidungsmerkmale des Mammuth in der Eingangs genannten Abhandlung niederzulegen.

Auf einer colorirten Tafel tritt uns dieses Riesenthier (Mamont der Russen) entgegen, wozu indess anhangsweise vom Verfasser bemerkt wird, dass nach den ihm später noch zugegangenen Mittheilungen die Mähne des Thieres, besonders auf dem Halse und Rücken, länger gewesen sey und nach unten bis an die Kniee gereicht haben möge, und dass dem Thiere keine schwarze, sondern vielmehr eine rothbraune Farbe zukäme.

Wiewohl sein Ansehen durchaus ein elefantenartiges gewesen ist, so übertraf es jedoch durch seine ansehnlichere Grösse, den stärker verlängerten Vorderkopf und den in allen Theilen des Skelets ausgesprochenen, kräftigeren, plumperen, an den dickeren, breiteren, jedoch nicht gerade kürzeren Extremitäten ebenfalls erkennbaren Bau die beiden (oder drei) noch lebenden Elefantenarten, und gewann durch die auf alle äusseren Theile, mit Ausnahme der Zähne und Hufe, ausgedehnte, dichte, mehr oder weniger lange Haarbedeckung, sowie die kleinen Ohren ein ganz eigenthümliches abweichendes Ansehen. Die Hauer übertrafen an Grösse bei weitem die der lebenden Elefanten. Wie die Richtung und Lage ihrer weiten Alveolen zeigt, waren die Hauer mit ihren Basaltheilen einander so genähert, dass sie mittelst derselben einen spitzen Winkel bildeten, bei ihrem Austritte sehr stark divergirten, sich dann zuerst nach aussen, vorn und oben wendeten, mit ihrem Endtheil oder ihrer Spitze aber nach aussen und hinten etwas gegen die Schulter hin sich bogen. Übrigens erscheinen die Hauer des Mammuth mehr oder weniger spiral, während die Backenzähne besonders durch die grössere Zahl ihrer, wie es scheint, etwas schmälern Platten und die schmälern Schmelzsäume derselben von denen des asiatischen Elefanten abweichen.

Es gibt die vorliegende Schrift nicht nur über diese bekannteren Verhältnisse in der Morphologie des Mammuth, sondern auch über andere bis jetzt nicht oder noch wenig verbreitete Thatsachen, welche besonders durch

* Vgl. „Zur Geschichte der Museen der Kais. Academie der Wissenschaften“ von J. F. RUPRECHT, F. BRANDT und A. GOEBEL. St. Petersburg. 40. 36 S.

das Lena-Mammuth zur Kenntniss gelangten, den gewünschten Aufschluss. — Wenn aber dessen Schädel z. B. noch jetzt den vertrockneten Augapfel wahrnehmen lässt, an welchem früher ADAMS selbst die Regenbogenhaut sah, und wenn man an diesem im gefrorenen Boden — nicht im reinen Eis, wie diess viele Naturforscher noch jetzt annehmen — an der Lena gefundenen Mammuth bekannter Maassen noch Fleisch und Haare, selbst Hirnreste derselben wohl conservirt angetroffen hat, so muss diese Thatsache bei der Entscheidung der jetzt so viel besprochenen Frage über das hohe Alter des Menschengeschlechtes, auf das man nach dem Zusammenvorkommen von Mammuthresten mit menschlichen Überresten geschlossen hat, wohl von höchster Bedeutung seyn.

Bei der wiederholten Entdeckung der verschiedenen Cadaver des Mammuth und des *Rhinoceros tichorhinus* im gefrorenen Boden liegt jedenfalls die Annahme weit näher, dass einzelne diluviale Thiere in die moderne Zeit übergegangen und erst vor wenigen Jahrtausenden — um ein Maximum zu nennen — ausgestorben sind, als dass man umgekehrt das Alter des Menschengeschlechtes aus demselben Grunde auf länger als hundert Tausend Jahre zurückversetzen zu müssen glaubt. (D. R.)

In einem Abschnitte „zur Lebensgeschichte des Mammuth“ spricht sich der geehrte Autor bezüglich des Untergangs des Mammuth in folgender Weise aus:

Überhaupt waren die Mammuth mit den büschelförmigen Nashörnern (*Rhinoceros tichorhinus*) diejenigen Glieder der grossen europäisch-asiatischen Thierwelt, welche zuerst, noch vor dem Riesenhirsch (*Cervus megaceros*) und dem Stammvater unseres gezähmten Rindes (*Bos primigenius*) verschwanden, ja zum Theil wenigstens vom Menschen vertilgt wurden, dem sie eine reichliche Quelle von Nahrung verschafften.

Dass die Vertilgung der Mammuth, wie die der Dronte*, der Steller'schen Seekuh**, des grossen Alk u. s. w. durch Menschen bewirkt worden sey, scheint auf den ersten Blick nicht recht glaublich, namentlich wenn sie mittelst Feuersteinwaffen hätte geschehen sollen, da die Mammuth in Frankreich zu einer Zeit untergegangen zu seyn scheinen, als die dortigen alten Bewohner noch keine Metallwaffen kannten. Bedenken wir indessen, dass man nicht bloss in Ostindien und auf Ceylon, sondern auch in Afrika, im Lande der Hottentotten, Elephanten in Gruben fängt, dass man ferner im alten Päonien, wie auch im alten Germanien, die wilden Ochsen in Gruben

* Über einige neuerdings entdeckte Knochen der Dronte oder des Dodo an der südwestlichen Küste von Rodriguez in einer trockenen Höhle mit stalaktitischen Gebilden, welche ihrer bedeutenderen Grösse halber als besondere Art, *Didus nazarenis* BARTLET, beschrieben worden sind, berichtet ALFR. NEWTON in *Ann. a. Mag. of Nat. Hist.* Vol. 16, No. 91, p. 61.

** *Rhytina Stelleri*, von welcher ein fast vollständiges Skelet nebst 2 Schädeln und einer Gaumenplatte in dem vergleichend-anatomischen Museum der Kais. Academie zu St. Petersburg bewahrt wird, ist nach den Untersuchungen der Akademiker v. BAER und BRANT seit 1768 nicht mehr lebend getroffen worden. (Vgl. J. F. BAER, einige Worte über die verschiedenen Entwicklungsstufen der Nasenbeine der Seekühe. (*Bull. de la Soc. imp. de St. Petersbourg*, T. V, p. 10—12. T. VI, p. 111—115. T. IX, p. 279—282.)

find, so könnten auch sehr wohl die alten Bewohner Galliens u. s. w. sich möglicher Weise dieser Methode zum Fange der Mammuth bedient haben.

In einer Mittheilung BRANDT's: über die bisher aufgefundenen Reste des *Elasmotherium* (Bull. de l'ac. imp. des sc. de St. Petersburg, T. VII, p. 480) hält es derselbe für wahrscheinlich, dass auch dieser zur Familie der Nashörner gehörige, aber durch seinen Zahnbau zu den Pferden hinneigende Dickhäuter als Zeitgenosse des Mammuth betrachtet werden könne. Herr BRANDT hat auch über Verwandtschaften, Körpergestalt, Lebensweise, Vaterland und die Daseyns- (Lebens-) Epoche dieser Gattung, womit er auch *Stereoceros* DUVERNOY nach Vorgang von KAUP vereint, eine vollständige Monographie bearbeitet „*Observationes de Elasmotherii reliquiis hucusque repertis institutae*“, die in den Memoiren der Petersburger Academie veröffentlicht wird.

J. W. DAWSON: über die Beschaffenheit der Steinkohlenablagerung, specieller erläutert an der Steinkohlen-Formation von Neu-Schottland und Neu-Braunschweig. (Quart. Journ. of the Geol. Soc. London. Vol. XXII, No. 86, p. 95—169, Pl. 5—13.) —

Die Gesamtmächtigkeit der Schichten, welche die Carbon-Formation in Nova Scotia zusammensetzen, ist von Sir LOGAN zu 14,570 Fuss bestimmt worden, wobei noch das unterste Glied dieser Reihe nicht eingeschlossen ist, wodurch ihre Mächtigkeit mindestens 16,000 Fuss betragen würde.

In ihrer gesammten Entwicklung lässt sich die Carbon-Formation in folgende Gruppen zerlegen:

a. Obere Steinkohlen-Formation, bestehend aus Sandsteinen, Schieferthonen und Conglomeraten mit wenigen schwachen Schichten von Kalkstein und Kohle. Darin sind *Calamites Suckovi*, *Annularia galioides*, *Cordaites simplex*, *Alethopteris nervosa*, *Pecopteris arborescens*, *Dadoxylon materiarum*, *Lepidophloios parvus* und *Sigillaria scutellata* die bezeichnendsten fossilen Pflanzen.

b. Mittle oder eigentliche productive Steinkohlen-Formation, die bauwürdigen Kohlenflötze enthaltend und frei von marinen Kalksteinen. Durch Eisenoxyd gefärbte Schichten treten hier weit mehr zurück als in jeder der anderen Etagen. Dunkelfarbige Schieferthone und graue Sandsteine herrschen vor, Conglomerate fehlen dagegen. Sigillarien und Stigmarien sind die ausgezeichnetsten und häufigsten Formen und alle Gattungen von Steinkohlenpflanzen haben hier ihre Repräsentanten. Mehrere Schichten, namentlich die in der Nähe der Kohlenlager, enthalten kleine *Entomostraca*, Schalen von *Anthracomya (Naiadites)*, *Spirorbis carbonarius* und Überreste von Ganoiden und Placoiden.

c. Die „*Millstone-grit*“-Gruppe. In ihrem oberen und mittleren Theile umschliesst diese kohlenfreie oder kohlenarme Gruppe dicke Schichten eines groben Sandsteins, in welchen Stämme von Coniferen (*Dadoxylon Acadianum*) eingeschwemmt liegen, in ihrem unteren Theile walten rothe und verhältnissmässig weiche Schichten vor.

d. Die untere marine Carbon-Formation. Wesentlich sind hier dicke Bänke eines marinen Kalksteins, hauptsächlich charakterisirt durch zahlreiche Brachiopoden, wie namentlich *Productus Cora*, *P. semireticulatus*, *Athyris subtilita*, *Terebratula sufflata* (in DAVIDSON'S Sinn) mit anderen marinen Invertebraten. Mit diesen Kalksteinen treten Gypsschichten zusammen auf, welche von starken Ablagerungen von Sandstein, Thon und Mergel mit vorherrschend rother Färbung eingeschlossen werden.

e. Die unteren Kohlenlager. In einigen Gegenden gleicht diese Gruppe in ihrem mineralogischen Charakter jener der eigentlichen productiven Etage; in anderen tritt eine grosse Mächtigkeit eigenthümlicher bituminöser und kalkiger Schiefer hervor. Sie enthalten häufig in ihrem unteren Theile mächtige Schichten von Conglomerat und grobem Sandstein, welche hier und da alle feineren Schichten verdrängen. Charakteristische Pflanzen für diese Etage sind *Lepidodendron corrugatum* und *Cyclopteris Acadica* mit *Dadoxylon antiquius* und *Alethopteris heterophylla* DAWSON. An einzelnen Stellen finden sich gleichzeitig grosse Mengen von Fischresten, viele Entomostraceen, mit *Leaia Leidy* und einer *Estheria*, ebenso *Leperditia subrecta* PORTL., *Beyrichia colliculus* EICHW. und eine Cythere.

Die beiden letzten Gruppen (d und e) entsprechen der subcarbonischen Zone einiger americanischer Geologen. —

Nachdem DAWSON ferner die physikalischen Bedingungen für die Ablagerungen in der Steinkohlen-Formation im Allgemeinen erläutert hat, gibt er eine specielle Schilderung des Charakters der verschiedenen Kohlenschichten in einem Durchschnitt von South Joggins mit ihren organischen Überresten, eine genaue Darstellung, welche sehr an die in dieser Beziehung die Bahn brechenden Untersuchungen von GÖPPERT und BEINERT erinnert.

Dem folgen Bemerkungen über Thiere und Pflanzen, deren Überreste man in der Steinkohlen-Formation antrifft, die um so schätzbarer sind, als hier das Resultat zahlreicher mikroskopischer Untersuchungen niedergelegt worden ist. Den Schluss bildet eine Übersicht aller bis jetzt in der Carbon-Formation von Neu-Schottland und Neu-Braunschweig beobachteten fossilen Pflanzen, unter denen alle neue und viele schon beschriebene Arten mit Diagnosen oder Erläuterungen versehen sind, wodurch die zahlreichen, gleichzeitig von DAWSON gegebenen Abbildungen zur Beurtheilung dieser reichen Flora recht nutzbar werden.

Wir lassen die Namen hier folgen, um einen Anhaltepunkt zu Vergleichen mit anderen Steinkohlenfloraen zu geben*.

Dadoxylon Acadianum n. sp. (M.), *D. Materialium* n. sp. (M. u. O.), *D. antiquius* n. sp. (U.), *D. annulatum* n. sp. (M.), welche 4 Araucariten nach mikroskopischen Präparaten unterschieden werden; *Araucarites gracilis* n. sp. (O.), dem *Lycopodites selaginoides* SR. sehr ähnlich, *Sigillaria elegans* BGT. (M.), *S. tessellata* BGT. (M.), *S. scutellata* BGT. (M. u. O.), *S. Schlotheimiana* BGT. (M.), *S. Saulli* BGT. (M.), *S. Browni* DAWSON. (M.), *S.*

* In dieser Liste bezeichnet O. die obere, M. die mittlere und U. die untere Etage der Steinkohlen-Formation.

renifrons BGT. (M.), *S. laevigata* BGT. (M.), *S. planicosta* n. sp. (M.), *S. catenoides* und *S. striata* n. sp. (M.), *S. Menardi* BGT. (M.), *S. Sydneensis* n. sp. (M.), *S. organum* L. & H. (M.), *S. elongata* BGT. (M.), *S. flexuosa* und *S. pachyderma* L. & H. (M.), *S. Bretonensis* n. sp., der *S. tessellata* nahe verwandt (M.), *S. eminens* n. sp. (M.), *S. Dournaisi* und *S. Knorri* BGT. (M.), *Syringodendron* BGT., zu *Sigillaria* gehörig, *Stigmaria ficoides* BGT., mit 11 Varietäten, die als Wurzeln von Sigillarien betrachtet werden, *Cyperites* L. & H., unter welchem Namen DAWSON noch die verschiedenen linearen Blätter der Sigillarien zusammenfasst, *Calamodendron approximatum* BGT. (M.), welche durch ihre mikroskopische Structur sich den Sigillarien nähert, *C. obscurum* n. sp., vielleicht ein *Calamites* (M.); *Antholithes* BGT. 3 Arten (M.), 1 Art (O.); *Trigonocarpon Hookeri* DAWS. (M.), *T. Noeggerathi* BGT. (O.), 5 Tr. n. sp. (M.), 1 *Rhabdocarpus* sp. (M.), 1 (O.), *Calamites Suckovi* BGT., *C. Cisti* BGT., *C. cannaeformis* SCHL. (M.), *C. ramosus* ARTIS (M.), *C. Voltzi* BGT., *C. dubius* ART. (M. u. O.), *C. nodosus* SCHL. (M.), *C. Nova-scotica* n. sp. (M.), *Equisetites curta* n. sp. (M.), *Asterophyllites foliosus* L. & H. (M.), *A. equisetiformis* L. & H. (= *Annularia longifolia*) (M.), *A. grandis* ? ST. (M.), *A. trinervis* n. sp. (M.), *Annularia galioides* ZENK. (statt *A. sphenophylloides* ZENK.) (M.), *Sphenophyllum emarginatum* BGT. (incl. *Schlotheimi* BGT. und *erosum* L. & H. (M.)), *S. longifolium* GERM. (O.), *S. saxifragae-folium* ST. (*S. bifurcatum* ? LESQ.), *Pinnularia* 3 sp., Wurzeln von *Asterophyllites* (M. u. U.), *Noeggerathia dispar* n. sp., *N. flabellata* L. & H. (M.), *Cyclopteris heterophylla* GÖ. (M. u. O.), *C. (Aneimites) Acadica* DAWS. (U.), *C. oblongifolia* GÖ. (O.), *C. (Neuropteris) obliqua* BGT. (M.), *C. (Neur.) ingens* L. & H. (M.), *N. oblata* L. & H. (M.), *C. fimbriata* LESQ. (M.), *C. hispida* n. sp. (M.), *C. antiqua* n. sp. (U.); *Neuropteris rarinervis* BUNB. (M.), *N. perelegans* n. sp. (M.), *N. cordata* BGT. (M. u. O.), *N. Voltzi* BGT. (M.), *N. gigantea* ST. (M. u. O.), *N. flexuosa* ST. (M.), *N. heterophylla* BGT. (M. u. O.), *N. Loshi* BGT., *N. acutifolia* BGT. (M.), *N. conjugata* GÖ. (M.), *N. attenuata* L. & H. (M.), *N. dentata* LESQ. (M.), *N. Soreti* BGT. (M.), *N. auriculata* BGT., *N. cyclopteroides* n. sp. (M.), *Odontopteris Schlotheimi* BGT. (M. u. O.), *O. subcuneata* BUNB. (M.), *Dictyopteris obliqua* BUNB., *Lonchopteris tenuis* n. sp. (M.), *Sphenopteris munda* n. sp. (M.), *S. hymenophylloides* BGT. (M. u. O.), *S. latior* n. sp. (M. u. O.), *S. decipiens* LESQ. (M.), *S. gracilis* BGT. (M.), *S. artemisiaefolia* BGT. (M.), *S. Canadensis* n. sp., *S. Lesquereuxi* NEWB. (M.), *S. microloba* GUTB. (M.), *S. obtusiloba* ? BGT. (M.), *Phyllopteris antiqua* n. sp. (M.), *Alethopteris lonchitica* ST. (M. u. O. sehr häufig!), *A. heterophylla* L. & H. (U.), *A. Grandini* BGT. (M.), *A. nervosa* BGT. (M. u. O.), *A. muricata* BGT. (M. u. O.), *A. pteroides* BGT. (U. u. M.), *A. Serli* BGT. (M.), *A. grandis* n. sp., *Pecopteris (Cyatheites) arborescens* SCHL. (M. u. O.), *P. abbreviata* BGT. (M.), *P. rigida* n. sp. (O.), *P. unita* BGT. (M. u. O.), *P. plumosa* BGT. (M.), *P. polymorpha* BGT. (M.), *P. acuta* BGT., *P. longifolia* BGT., *P. taeniopteroides* BUNB. (M.), *P. cyathea* BGT. (M.), *P. aequalis* BGT. (M.), *P. Sillimani* ? BGT., *P. villosa* BGT. (M.), *P. Bucklandi* BGT. (M.), *P. oreopteroides* BGT. (M.), *P. decurrens* LESQ. (M.), *P. Pluckenetii* SCHL. (M.),

Beinertia Goepperti n. sp. (M. u. O.), *Hymenophyllites pentadactylus* n. sp. (M.), *Palaeopteris Harti* n. sp. (M.), *P. Acandica* n. sp. (O.), *Caulopteris* sp. und *Psaronius* sp., *Megaphytum magnificum* n. sp. und *M. humile* n. sp. (M.), *Lepidodendron corrugatum* DAWSON (ad ? *Lycopodites*) (U.), *L. Pictoense* n. sp. (an ? *Lycopodites selaginoides* ST.) (M.), *L. rimosum* ST. (*Sagenaria* sp.) (M.), *L. dichotomum* ST. (M. u. M.), *L. decurtatum* n. sp. (M.), *L. undulatum* ST. (ad *Aspidiaria*) (M. u. O.), *L. dilatatum* L. & H. (M.), *L. tetragonum* ? GÖ. (U.), *L. binerve* BUNB., *L. tumidum* BUNB. (M.), *L. gracile* BGT. (M.), *L. elegans* BGT. (M.), *L. plumarium* L. & H. (M.), *L. selaginoides* ST. (ad *Lycopodites*) (M.), *L. Harcourtii* WITH. (M.), *L. clypeatum* ? LESQ. (M. u. O.), *L. aculeatum* ST. (M.), *L. plicatum* n. sp. (an ? *Sagenaria rimosa* ST. (M.), *L. personatum* n. sp. (M.), *Halonias* sp., *Lepidostrobus variabilis* L. & H. (M.), *L. squamosus* n. sp. (M.), *L. longifolius* n. sp. (M.), *L. sp.* (M.), *L. sp.* (U.), *L. trigonolepis* BUNB. (M.), *Lepidophyllum lanceolatum* L. & H. (M. u. O.), *L. trinerve* ? L. & H. (O.), *L. majus* ? BGT. (M.), *L. intermediam* L. & H. (M.), *Lepidophlois Aca-dianus* n. sp. (M.), *L. prominulus* n. sp. (ad ? *Sigillaria*) (M.), *L. parvus* n. sp. (ad ? *Ulodendron* an ? *Sagenaria*) (M. u. O.), *L. platystigma* n. sp. (M.), *L. tetragonus* n. sp. (M.) (meist zu *Lepidodendron* gehörend, *Diptotegium retusum* n. sp. (M.), *Knorria Selloni* ST. (M.), *Cordaites borassifolius* CORDA (M. sehr häufig!), *C. simplex* n. sp. (M. u. O.), *Cardiocarpum fluitans*, *C. bisectum*, *C. prope marginatum*, *C. prope latum* NEWB. n. sp. (M.), *Sporangites*, worunter Sporenkapseln von *Lepidodendron*, *Calamites* u. a. Pflanzen zusammengefasst werden, 2 sp., von denen eine, *S. papillata* n. sp., dem *Carpolithus coniformis* GÖ. ähnlich scheint, *Sternbergia* sp., *Endogenites* sp. und *Solenites* sp. —

Diese Liste enthält ausser den von DAWSON beobachteten auch die von Sir W. E. LOGAN, RICH. BROWN in Sydney, H. POOLE von Glace Bay, G. F. und C. B. MATTHEW und C. F. HART in St. John, New-Brunswick gesammelten Pflanzenreste, so dass sie den gegenwärtigen Standpunkt in der Kenntniss dieser fossilen Flora bezeichnet. —

Bei einem Vergleiche der Vertheilung dieser Flora mit jener in den verschiedenen Zonen der Steinkohlen-Ablagerungen Europa's fällt zunächst auf, dass man auch dort die Zone der unteren Kohlenlager wie in Europa als *Lycopodiaceen-Zone* bezeichnen muss, da *Lepidodendron corrugatum* die am meisten bezeichnende und vorherrschende Pflanze darin ist. Diese Art steht aber in der That dem *Lycopodites polyphyllus* RÖM. sp. (GRINITZ, Flora des Hainichen-Ebersdorfer Kohlenbassins, Taf. III, f. 1, 2) so nahe, dass man beide für identisch halten möchte, während *Lep. tetragonum* ST. (GRIN. eb. Taf. III, f. 1, 2) und die ausgezeichnete *Knorria imbricata* ST. (GRIN. eb. Taf. VIII, f. 3; IX, f. 1—4), die wir noch immer für eine selbstständige Pflanze halten müssen, gleichfalls für die älteste Steinkohlenformation oder den Culm Europa's ganz charakteristisch sind. Auch *Cyclopteris Acandica* DAWSON der unteren Kohlenlager Nordamerika's ist wenigstens die nächste Verwandte der *Cyclopteris tenuifolia* GÖPP. im deutschen Culm.

Das Vorherrschen der Sigillarien und Stigmarien in der mittlen, unter b. bezeichneten Gruppe beweist die Identität dieser Zone mit unserer europäischen Sigillarien-Zone und insbesondere fällt die Analogie mit der Flora der Hauptsteinkohlenlager Englands und Irlands namentlich auch durch die grosse Verbreitung der dort nie fehlenden *Alethopteris lonchitica* auf.

Wenn DAWSON endlich S. 106 hervorhebt, dass in der obersten Abtheilung von Sir LOGAN's Durchschnitt bei South Joggins, welche dem oberen Theile der oberen Steinkohlen-Formation entspricht, Stämme von Coniferen und Calamiten — *Cal. Suckovi*, *C. Cisti*, *C. approximatus*, neben *Aspidiaria undulata*, *Lepidophloios parvus* und *Stigmaria ficoides* — die häufigsten Fossilien sind, so wird man diese Zone nahezu der Calamiten-Zone oder dem dritten Vegetationsgürtel in Deutschland gleichstellen können.

Hiermit würde die Reihenfolge in der Flora der Steinkohlen-Formation, wie wir dieselbe für Europa erkannt haben, durch DAWSON's gründliche Forschungen schon heute für Amerika bestätigt worden seyn und es werden sich hieran wahrscheinlich bald fernere Mittheilungen über das Vorhandenseyn der beiden oberen Zonen, Annularien- und Farren-Zone, in erfreulicher Weise anschliessen.

H. B. G.

H. R. GÖPERT: über *Aphyllostachys*. (Act. d. Leop.-Car. Ac. Vol. XXXII.) 16 S., 2 Taf. — Der hier beschriebene Pflanzenrest ist bei Enger im Hannöver'schen in einer wahrscheinlich dem Lias angehörigen Formation in röthlichem, an Eisenoxyd reichem, einer Eisenniere ähnlichem Gesteine gefunden worden. Derselbe zeigt das obere Ende eines aus fünf Wirteln mit Fruchthähren zusammengesetzten Fruchtstandes. Jeder dieser Wirtel enthält 8—9 linearisch-cylindrische, nach oben etwas zugerundete Ähren von 5—6 Linien Länge und $1\frac{1}{2}$ —2 Linien durchschnittlicher Breite, die sich in einen kurzen Stiel verschmälern. Blätter an der Basis der Ähren fehlen, jedoch scheinen die länglich quadratischen Fruchtkapseln, die in den Ähren ringförmig angeordnet stehen, damit versehen gewesen zu seyn.

Diese unter dem Namen *Aphyllostachys Jugleriana* eingeführte Pflanze erinnert zunächst an die Fruchtstände mehrerer Steinkohlenpflanzen aus der Familie der Calamarien, inclusive *Asterophyllites* und *Sphenophyllum*, sowie das *Aethophyllum speciosum* des bunten Sandsteins und wird daher diesen Pflanzen genähert. Der jedenfalls ganz treuen Abbildung nach zu schliessen, scheint uns noch eine nähere Verwandtschaft mit *Equisetites infundibuliformis* Br. stattzufinden, und wir würden wenig Bedenken tragen, *Aphyllostachys* für einen *Equisetites* zu halten.

Glücklicher Weise, muss man aussprechen, ist GÖPERT's etwas andere Auffassung gerade die Veranlassung zu der vorliegenden Meisterarbeit geworden, welche hauptsächlich das Verhältniss der fossilen Flora zu DARWIN's Transmutations-Theorie bespricht.

Nach einer eingehenden Beleuchtung der hier einschlagenden Verhältnisse gelangt GÖPERT zu dem Schluss, dass die Lehre der Verwandlung oder Transmutation von der fossilen Flora auch nicht die

geringste Stütze zu erwarten hat, ebensowenig, wie von der fossilen Flora, wie REUSS jüngst entschieden nachgewiesen hat.

UNGER: Notiz über fossile Hölzer aus Abyssinien. (Kais. Ac. d. Wissensch. in Wien, 1866, No. XVIII.) Hofrath v. HEUGLIN hat dieselben im Jahre 1862 auf einer Reise in Abyssinien und zwar in den Hochländern um die Djidda und den Bäschlo, sowie in Wadla gesammelt, wo sie in einer Höhe von neun- bis zehntausend Fuss vorkommen. Sie erscheinen hier in grosser Menge theils als Stämme von $1\frac{1}{2}$ —2 Fuss im Durchmesser, theils in zahllosen Trümmern in einem Conglomerate, welches den vorherrschend vulcanischen Boden bedeckt. Ihre Verkieselung an Ort und Stelle aus den noch gegenwärtig vorhandenen zahlreichen heissen Quellen unterliegt keinem Zweifel.

Es war nun die Frage, ob dieses versteinerte Holz aus mehreren Arten bestehe und ob diese schon zu den beschriebenen Formen gehören oder nicht. Die anatomische Untersuchung hat gezeigt, dass, so mannigfaltig auch das äussere Ansehen dieser Fossilien ist, sie doch ohne Ausnahme nur einer einzigen Baumart angehört haben; ferner, dass dieses Holz mit jenem des sogenannten versteinerten Waldes bei Cairo eine und dieselbe Gattung, nämlich *Nicotia aegyptiaca* UNG. bilde, welche nach vergleichenden Untersuchungen mit recenten Hölzern zu schliessen, sich an die Familie der Sterculiaceen und Bombaceen anschliesst.

Es ist nun aus diesen Untersuchungen ersichtlich, dass der Ursprung des Holzes des versteinerten Waldes bei Cairo in den Hochländern Abyssiniens zu suchen sey, was der Verfasser zum Theil schon früher andeutete, indem er jenes Holz vor seiner Verkieselung als vom Nile heruntergelflösst betrachtete.

Die dem Holze mitgesendeten Kohlen haben keine nähere Bestimmung in Bezug auf ihren Ursprung aus Pflanzenresten zugelassen.

Dr. CONST. v. ETtingshausen: die fossile Flora des mährisch-schlesischen Dachschiefers. Wien, 1865. 4^o. 40 S., 7 Taf. (Denkschr. d. Kais. Ac. d. Wiss. Bd. XXV.) —

Das mährisch-schlesische Grauwacken-Gebirge erstreckt sich zwischen den Städten Olmütz und Troppau von dem östlichen Abfalle des Altvaters bis zu der von der Prerau-Oderberger Bahn berührten Einsattelung, in welcher die Oder und die Beetzwa nach entgegengesetzten Richtungen fliessen.

In der östlichen Hälfte des Gebirges kommen mehrere Lager von Dachschiefer vor, deren Abbau die Grundlage einer sich immer kräftiger entwickelnden Industrie bildet. Die in denselben aufgefundenen und hier besprochenen Pflanzenreste verweisen diese Schiefer in die Region des Culm oder zu gleichalterigen Bildungen mit der älteren Steinkohlen-Formation von Hainichen und Ebersdorf in Sachsen und anderen dem Kohlenkalke in ihrem Alter entsprechenden oder zunächst liegenden Ablagerungen.

Ausser 2 als *Chondrites* bestimmten Arten, die man wohl auf *Sphenophyllum dissectum* zurückführen kann, gehören sämtliche Pflanzen dem Festlande an. Wie bei Hainichen und Ebersdorf vermisst man unter letzteren die Sigillarien, denn es ist viel wahrscheinlicher, dass die vom Verfasser hierzu gezogene *Stigmaria* von *Sagenaria* oder einer anderen Lycopodiacee, als von einer *Sigillaria* abstammt.

Als Lycopodiaceen werden *Lepidodendron tetragonum* STB., *Sagenaria Veltheimiana* St., *Sag. acuminata* Gö. und *Megaphyllum simplex* Gö. hervorgehoben.

Eine der wichtigsten Leitpflanzen ist auch hier *Calamites transitionis* Gö.

Mit Unrecht vereinigt aber v. ETTINGSHAUSEN mit letzterem *Sphenophyllum dissectum* GUTB. (*Sph. furcatum* GRIN., Flora d. Hainichen-Ebersdorfer Kohlenbassins), dessen dichotome Blätter von den stets einfachen Blättern der Calamiten sehr abweichen.

Wir sollten meinen, dass die zwischen Calamiten und Asterophylliten oder Sphenophylliten bestehenden Unterschiede erheblich genug seyen, um beide von einander zu scheiden und müssen von neuem hervorheben, dass

1) bei Calamiten und Equisetiten die Zweige sich um den ganzen Stengel herum verbreiten, während dieselben bei *Asterophyllites* und *Sphenophyllum* sich nur nach zwei gegenüberstehenden Seiten entwickeln;

2) dass der Stengel der ersteren an den Gelenken stets mehr oder weniger eingeschnürt ist, während er bei den letzteren in Folge der festeren, die einzelnen Glieder des Stengels vollkommener trennenden Scheidewände, hier mit einem mehr oder weniger vorstehenden Rande versehen ist, wie diess v. ETTINGSHAUSEN selbst Taf. I, f. 4 und Taf. II, sowie Taf. III, f. 2—5 und Taf. IV, f. 4 recht deutlich abbildet. Diese Abbildungen stellen das *Sphenophyllum dissectum*, nicht aber einen *Calamites transitionis* dar. Dass auch *Equisetites Göpperti* ETT., Taf. IV, f. 2 zu diesem *Sphenophyllum* gezogen werden kann, scheint uns weit eher gerechtfertigt zu seyn, als die Vereinigung dieser Form mit *Sphaerococcites Scharyanus* Gö. aus Böhmens Silurformation, welche nach BARRANDE in der Etage E vorkommt.

Zu *Calamites communis* ETT. werden vom Verfasser nicht nur fast sämtliche Calamiten gestellt, die aus der productiven Steinkohlen-Formation bekannt geworden sind, wie *Cal. cannaeformis*, *Cal. Suckovi* und *Cal. approximatus*! mit ihren zahlreichen Abänderungen, sondern auch mehrere Asterophylliten.

Wir schätzen die werthvollen Arbeiten v. ETTINGSHAUSEN's in einem sehr hohen Grade, können aber seine Auffassung des *Calamites communis*, einer aus verschiedenen Gattungen und 5 bis 6 von fast allen Autoren anerkannten Arten construirte Art, nur als einen Irrthum bezeichnen.

Am häufigsten sind in diesen Dachschiefern Farrenkräuter, wie *Sphenopteris elegans* BGR., *Sph. distans* St. und *Sph. lanceolata* ? GUTB., *Neuropteris Loshi* BGR. und *N. heterophylla* BGR., 2 neue Arten *Cyclopteris*, *Gymnogramme obtusiloba* ETT., die wir lieber mit *Sphenopteris distans* als mit *Sph. obtusiloba* BGR. vereinigen würden, 1 *Adiantum*, 1 *Asplenium*,

5 *Trichomanes*, worunter *Hymenophyllites dissectus* Gö., *Hymenophyllites quercifolius* Gö. und *H. patentissimus* ETT., 1 *Schizaea*, 1 *Aneimia* und *Schizopteris Lactuca* ? PRESL.

Noeggerathia palmaeformis Gö. und *N. Rueckeriana* Gö. sind als Monocotyledonen, Stigmarien aber als Dicotyledonen, als Pflanzen von unsicherer Stellung aber die auch im Culm von Sachsen und Schlesien bekannten Früchte, *Trigonocarpum ellipsoideum* Gö. und *Rhabdocarpus conchaeformis* Gö., aufgeführt.

Als eine interessante Beigabe zu dieser Abhandlung finden wir S. 8 eine Tabelle zur Vergleichung der fossilen Flora des mährisch-schlesischen Dachschiefers mit der Flora der Jetztwelt.

FR. V. HAUER: die Cephalopoden der unteren Trias der Alpen. (Sitzungsb. d. kais. Ac. d. Wiss. Bd. LII. 7. Dec. 1865. 36 S., 3 Taf.) — Es ist höchst erfreulich, zu sehen, wie fast jeder Tag einen Fortschritt auch in der Geologie der Alpen bringt. Aus den gegenwärtigen Mittheilungen ergibt sich, dass in der unteren alpinen Trias zwei ganz gesonderte Cephalopodenfaunen vorhanden sind, deren ältere begleitet wird von den bekannten Fossilien der Werfener und Guttensteiner Schichten (= bunter Sandstein), während die jüngere dem Virgloriakalke (= Muschelkalk) angehört.

I. Cephalopoden aus den Werfener und Guttensteiner Schichten sind:

Ceratites Cassianus QU., *C. Idrianus* HAU., *C. Muchianus* HAU., *C. dalmaticus* HAU., *C. Liccanus* HAU.;

II. Cephalopoden aus dem Virgloriakalke:

Orthoceras sp., *Nautilus bidorsatus* SCHL., *N. Pichleri* HAU., *Ceratites binodosus* HAU. (*Amm. antecedens* BEYR.), *Amm. Dontianus* HAU. (? *A. Dux* GIEB.), *A. Studeri* HAU. (*A. pseudoceras* GÜ., *A. cochleatus* OPP., *A. rugifer* OPP.) etc. —

Unter den von GÜMBEL und SCHAFFHÄUTL beschriebenen Ammoniten aus dem Salzbergbau von Berchtesgaden, *Amm. Berchtesgadensis* GÜ. (*A. heterophyllus* SCH.), *A. salinatus* GÜ. und *A. pseudoeryx* GÜ., aus einem hellgrauen Kalkstein, welchen GÜMBEL für ein Äquivalent des bunten Sandsteins (der Werfener Schichten) hält, kann keiner mit einer der genauer bekannten Arten aus der unteren alpinen Trias in Verbindung gebracht werden, vielmehr erinnert ihr Habitus mehr an obertriadische Formen.



HENRY DARWIN ROGERS, einer der bekanntesten und ausgezeichnetsten amerikanischen Geologen, geb. 1819 in Philadelphia, ist am 29. Mai d. J. zu Glasgow in Schottland verstorben, wo er seit 1857 eine Professur der Geologie und Naturgeschichte einnahm. (Nekrolog s. in SILLIMAN und DANA,

American Journal, July 1866, p. 136 und in *The Geolog. Magazine*, No. 25, 1866. —

Durch Prof. J. MARCOU erhalten wir die betrübende Nachricht, dass Herr L. SAEMANN in Paris am 23. August d. J. im Alter von etwa 45 Jahren gestorben ist. Diess ist ein Verlust für die Wissenschaft, da Herr SAEMANN, welcher als vielgereister Kaufmann besonders Verbindungen zwischen deutschen und französischen Geologen und Mineralogen unterhielt, allen Männern der Wissenschaft gegenüber höchst liberal war, was er durch Darleihung seltener Exemplare oder durch Überlassung seiner reichen Bibliothek vielfach bekrundet hat. —

Am 2. Sept. d. J. verschied Dr. med. LUDWIG HOCKE in Schönlinde, dem wir die erste Entdeckung deutlicher jurassischer Versteinerungen bei Khaa in Böhmen verdanken (Jb. 1865, 214).

Versammlungen.

Die ausserordentliche Versammlung der französischen geologischen Gesellschaft wird am 7. October zu Bayonne (*Basses Pyrénées*) beginnen.

Verkauf einer Petrefacten-Sammlung.

Herr AD. LASARD in Pr. Minden beabsichtigt wegen Domizilveränderung, seine reiche Petrefacten-Sammlung bis zum November d. J. zu verkaufen. Alle Formationen von der silurischen bis zur Tertiärformation — letztere aus 20 bis 30 Localitäten — sind in vollständigen Suiten in derselben vertreten; unübertroffen und in keiner anderen Sammlung erreicht sind die norddeutschen Jura- und Kreideversteinerungen, namentlich aus den berühmtesten Fundstätten Hannovers, Braunschweigs und des Wesergebirges. Neben letzteren sind die schwäbischen und Solenhofener Schichten in allen hauptsächlichsten Versteinerungen vertreten. Ausser den in ca. 350 Auszügen geognostisch geordneten, meistens nach den neuesten Quellen bestimmten Versteinerungen sind 4 grosse, ganz vollständige und vorzüglich erhaltene Ichthyosaurier, 1 *Teleosaurus* (11½ Fuss lang) von seltener Schönheit, ein *Plesiosaurus* (dieser nur Abguss), eine reiche Anzahl Fische, Chirotherien, Pentacriniten, mehr als 20 Encriniten, darunter viele mit Stiel, sowie eine bedeutende Anzahl grosser Ammoniten vorhanden. Für jedes öffentliche Institut ist der Erwerb dieser viele Unica enthaltenden Sammlung sehr zu empfehlen. Reflektanten wollen sich direkt an den Besitzer wenden; Anträge von Mineralienhändlern werden nicht berücksichtigt, da Herr LASARD seine Sammlung womöglich einem öffentlichen Institut einverleibt zu sehen wünscht.

Wissenschaftlichen Instituten kann der Ankauf durch Stundung der Kaufsumme auf mehrere Jahre oder durch ratenweise Abtragung derselben erleichtert werden.

BEITRAG
ZUR
NÄHEREN KENNTNISS DER CALAMITEN.

VON
DR. CONSTANTIN V. ETTINGSHAUSEN.

(Mit 4 lithographirten Tafeln.)

(Aus dem Octoberhefte des Jahrganges 1852 der Sitzungsberichte der mathem.-naturw. Classe der kais. Akademie der Wissenschaften [Bd. IX, S. 684] besonders abgedruckt.)

BEITRAG

NÄHEREN KENNNTNIS DER CALAMITEN.

Als ich im Jahre 1841 die erste Ausgabe des
von mir herausgegebenen „Handbuchs der
Geologie“ veröffentlichte, so war die Kenntnis der
Calamiten noch sehr unvollständig. Seitdem
ist die Wissenschaft in diesem Fache sehr
fortgeschritten. Die Calamiten sind jetzt
nicht mehr als seltene, merkwürdige
Fossilien betrachtet, sondern als wichtige
Zeichen der geologischen Zeitrechnung.
Die Calamiten sind in der That
eine sehr wichtige Gruppe von Fossilien,
die uns sehr viel über die geologische
Geschichte der Erde verraten. Sie sind
nicht nur in der That, sondern auch
in der Theorie eine wichtige Gruppe.
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nicht nur in der That, sondern auch
in der Theorie eine wichtige Gruppe.

Beitrag zur näheren Kenntniss der Calamiten.

Von Dr. Constantiu v. Ettingshausen.

(Mit vier Tafeln.)

Als ich im Herbste des Jahres 1851 die verschiedenen Vorkommen von Pflanzenfossilien in der Steinkohlenmulde von Radnitz in Böhmen untersuchte, fiel mir in dem an Calamiten vorzüglich reichen Schieferthon von Wranowitz das häufige Vorkommen eines Petrefactes auf, welches theils den Habitus der Calamiten, theils den der Equisetiten an sich trägt, jedoch von den bisher bekannt gewordenen Stämmen der Ersteren durch den Mangel der Längsrippen und durch scheibenförmige Wülste, die an den Gliederungen stets in einem Quirl mehr oder weniger gedrängt stehen, von den letzteren aber durch den Mangel der Scheiden auffallend verschieden ist. Auch in dem Steinkohlensandsteine von Swina bei Radnitz, in welchem die Calamiten ungleich seltener vorkommen, fand sich dieses Fossil, jedoch ebenfalls entsprechend selten. Überhaupt konnte ich eine gewisse Beziehung desselben zu den Calamiten schon dem Vorkommen nach nicht verkennen, obgleich ich nicht im Stande war, einem directen Zusammenhange dieser Pflanzengebilde auf die Spur zu kommen.

Bei der Durchsicht der schönen und interessanten Petrefactensammlung des Herrn Hofrathes Bronn in Heidelberg wurde mir nun wesentliche Aufklärung über dieses zweifelhafte Gebilde zu Theil. Ich sah daselbst mehrere Bruchstücke des *Equisetites columnaris* Sternb. mit deutlich erhaltenen, an der Gliederung im Quirl geordneten Astnarben. Diese Bruchstücke sind den eben erwähnten equisetitenartigen Fragmenten aus der Steinkohlenformation ausser-

ordentlich ähnlich. Ausserdem machte mich Herr Prof. Bronn auf ein eigenthümliches Zusammenvorkommen des *Calamites arenaceus* Brongn. mit dem *Equisetites columnaris* Sternb. aufmerksam. Er beobachtete an mehreren Exemplaren von der Feuerbacher Haide ein Einschaltensein des Ersteren in dem Letzteren, welches unmöglich zufällig gebildet sein kann, sondern deutlich erkennen lässt, dass der *Equisetites columnaris* nichts anderes als die äussere Rinde des *Calamites arenaceus* ist und somit diese beiden, bisher verschiedenen Geschlechtern untergeordneten Fossilien die Axentheile einer und derselben Pflanze darstellen ¹⁾.

Ich kann die Richtigkeit dieser Beobachtung auf das Vollkommenste bestätigen. Auch in den Sammlungen des Hrn. Prof. Blum in Heidelberg, des Hrn. Bergrathes Walchner in Karlsruhe und in der Sammlung des böhmischen National-Museums zu Prag sah ich Exemplare von *Equisetites columnaris* und *Calamites arenaceus*, welche diese Thatsache ausser allen Zweifel setzen.

Es ist daher auf Grundlage dieser Analogie wohl anzunehmen, dass die Radnitzer Fossilien nichts anderes sind als die Fragmente der äusseren Rinde eines Calamiten und zwar, da dieselben gleiche Häufigkeit und gleiches Vorkommen mit dem *Calamites communis* Ettingsh. zeigen, zu dieser Art gehören. Diese äussere Rinde musste sich von dem, an seiner inneren Fläche gerippten, den hohlen Calamiten-Stamm bildenden Holzeylinder ²⁾ durch Maceration leicht abgetrennt haben, so dass wir nur in den seltensten Fällen, wo besondere Umstände der Erhaltung gebrechlicher oder leicht trennbarer Pflanzentheile günstig waren ³⁾, den Zusammenhang dieser Gebilde beobachten können.

¹⁾ Auch Quenstedt fand einen *Calamites arenaceus* als Kern in einem *Equisetites columnares*. S. Bronn's Jahrb. f. Min. 1842, S. 305.

²⁾ Ich schliesse mich der von Petzhold ausgesprochenen Ansicht, dass die gewöhnlich als Stämme der Calamiten betrachteten Fossilien mit sehr scharf ausgeprägten Längsrippen und Quergliederungen nur Steinkerne der Calamiten sind, an.

³⁾ Gewiss waren hiezu die Vorgänge, welche die Ablagerungen des Keuper-sandsteines begleiteten und die wenigstens stellenweise eine schleunigere Umhüllung der Pflanzenabfälle bewirkten, eher geeignet, als die Bildungsvorgänge der Schieferthone der Steinkohlenformation, der Thone und Mergel der Keuper- und Liasformation. Auch in dem Liasmergel von Gaming in Ober-Österreich, wo sowohl der *Calamites arenaceus* Brongn.,

Beschreibung der Arten.

Ord. CALAMITEAE.

Calamites communis Ettingsh.

Ettingshausen, Beiträge zur Flora der Vorwelt. Naturwissenschaftliche
Abhandlungen von W. Haidinger. IV. Bd., 1. Abth., S. 73.

Taf. I, Fig. 1—2.

„ II, „ 1.

C. caule cylindrico, articulado, tubuloso; cortice laevi vel irregulariter striata et plicata, vaginis nullis; cicatricibus ramorum articulationi verticillatim insidentibus, rarius solitariis, rotundatis, verrucaeformibus; costis 2½ — 8 millm. latis, tuberculis rotundatis, ramis caducis, articulatis, longitudinaliter elevato-striatis, striis 1 — 2 millm. remotis, apice tuberculis seu cicatricibus foliorum impressis; foliis verticillatis, crebris, ramorum linearibus, patentibus, deciduis, ramulorum brevioribus acicularibus, saepius sursum flexis; spicis cylindricis, 6 — 12 centm. longis pedunculatis, bracteis verticillatis, in spicis fructiferis linearibus, attenuato-acuminatis vel subulatis, patentibus, arcuato-falcatis, in sterilibus longioribus, late linearibus, obtusiusculis, erecto-patentibus, uninerviis, planis; sporocarpis in axillis bractearum solitariis, sessilibus, obovatis, nuculaeformibus.

In formatione lithanthracum Bohemiae, Silesiae, Germaniae, Galliae, Angliae, Rossiae et Americae septentrionalis frequens.

Bezüglich der zahlreichen dieser Art zufallenden Synonyme, welche hauptsächlich dadurch angehäuft worden, dass man einerseits die verschiedenen Theile derselben (Stämme, die leicht abfälligen Äste und Ästchen, Fructificationsstände) als verschiedene Arten betrachtete, die man dem Geschlechte, ja selbst der Familie nach

als alle Formen des *Equisetites columnaris* Sternb. sehr häufig vorkommen, konnte ich einen derartigen Zusammenhang dieser Fossilien nicht auffinden.

trennte, andererseits aber einzelne Entwicklungsstufen dieser Theile ja sogar zufällige, durch äussere Einwirkungen an diesen Theilen hervorgerufene Veränderungen als eigenen Arten¹⁾ angehörige Formen ansah — verweise ich auf die oben citirte Abhandlung. Nur habe ich noch die *Cyclocladia major* Lindl et Hutt. hinzuzufügen, ein Fragment, welches in allen seinen Merkmalen, insbesondere aber in der Art der Gliederung und der an derselben im Quirl geordneten, grossen Astnarben mit den hier abgebildeten Fossilresten vollkommen übereinstimmt.

Calamites arenaceus Brongn.

Brongniart, Hist. végét. foss. I. p. 138, t. 23, f. 1, t. 25, f. 1, t. 26, f. 3—5. — Ann. sc. nat. tom. 15, p. 437, t. 15. — Jäger, Pflanzenversteiner. p. 37, t. 3, f. 1—7, t. 6, f. 1.

Taf. II, Fig. 1.

„ III, „ 1—3.

„ IV, „ 1—2.

C. caule cylindrico, articulado, cortice laevi vel longitudinaliter sulcata, vaginis sub articulationibus insertis, erectis multidentatis vel multifidis; cicatricibus ramorum articulationi verticillatim insidentibus, prominentibus, rotundatis, costis 1 — 2½ millm. latis, superiori parte angustissimis, basi latioribus, tuberculis minutis, rotundatis saepe nullis, ramis caducis, articulatis, caule multo angustioribus, striatis ad articulationes saepe tumidis.

Syn. *Calamites arenaceus minor* Jaeger Pflanzenverstein. p. 37, t. 3, f. 1—7, t. 6, f. 1, t. 4, f. 5, 9.

Calamites Jaegeri Sternb. Vers. II, p. 21.

Calamites remotus Brongn. Annal. des scienc. nat. tom. XV. p. 438. — Hist. végét. foss. p. 136, t. 25, f. 2.

Calamites elongatus Sternb. Vers. II, p. 49.

Equisetites columnaris Sternb. Vers. II, p. 45.

Equisetum columnare Brongn. Hist. végét. foss. I. p. 115, t. 13.

Oncylogonatum carbonarium Koenig, Transact. of Geol. Soc. Ser. II, tom. II, p. 300, t. 32, f. 1—6.

Equisetites acutus Sternb. Vers. II, p. 107, t. 31, f. 3.

Equisetites cuspidatus Sternb. Vers. II, p. 106, t. 31, f. 1, 2, 5, 8.

¹⁾ *Calamites undulatus* Sternb., *C. pachyderma* Brongn., *C. columella* Kut.

Equisetites Bronnii Sternb. Vers. II. p. 46, t. 21, f. 1—5,
t. 30, f. 4. 6.

Equisetium arenaceum Bronn. Jahrb. für Mineral. 1829, n. 5, p. 75.

Equisetites Schoenleinii Sternb. Vers. II, p. 45.

Equisetites Sinsheimicus Sternb. Vers. II, p. 107, t. 30, f. 2.

Equisetites areolatus Sternb. Vers. II, p. 107, t. 30, f. 3.

Equisetites conicus Sternb. Vers. II, p. 44, t. 16, f. 8, t. 30, f. 1.

Equisetites elongatus Sternb. Vers. II, p. 107, t. 31, f. 7.

Equisetites austriacus Ung. Gen. et Spec. plant. foss. p. 57.

*In formatione Keuper dicta regni Würtembergensis, magni-
ducatus Badensis et ad Herbipolim; in variis locis Fran-
coniae et Galliae; ad Gaming, Wienerbrückl, Kirchberg
et Waidhofen Austriae nec non in psamite versicolore
per totum tractum montium Vogesiorum.*

Sämmtliche hier abgebildeten Exemplare stammen von der Feuer-
bacher Haide bei Stuttgart. Die auf Taf. II, Fig. 2 und Taf. IV,
Fig. 1, dargestellten, sind Original-exemplare des von Sternberg
aufgestellten *Equisetites Bronnii* (Vers. II, tab. 21, f. 4, 5).
Diese Form, welche sich nur durch mehr oder weniger verkürzte
Glieder und ziemlich entfernt stehende Längsstreifen kenntlich macht,
sowie die Stammformen von *Equisetites acutus*, *E. Schoenleinii*,
elongatus *E. cuspidatus*, *E. sinsheimicus* und *E. areolatus*
sind durch so zahlreiche Übergänge mit dem *Equisetites colum-
naris* Sternb. verbunden, dass es wohl nicht dem geringsten
Bedenken unterliegen kann, dieselben unter den Begriff Einer
Species zusammenzufassen. Das Gleiche gilt auch von den Schei-
denfragmenten, welche Sternberg unter der Bezeichnung *Equi-
setites conicus* und *E. elongatus*, als besonderen Arten angehörig,
unterschied. Diese Übergangsformen fanden sich nicht nur im Ge-
biete des Keupersandsteines Württembergs und Badens, sondern auch
in den Kalkmergeln der österreichischen Liasformation, wo der
Equisetites columnaris sehr häufig vorkommt, aber auch Typen
erscheinen, die ganz wohl zu *E. acutus*, *E. cuspidatus*, *E. sins-
heimicus*, *E. conicus* gebracht werden könnten.

Übersicht der Tafeln.

Tafel I.

- Fig. 1—2. *Calamites communis* Ettingsh. von Radnitz in Böhmen. In der Sammlung der k. k. geologischen Reichsanstalt.

Tafel II.

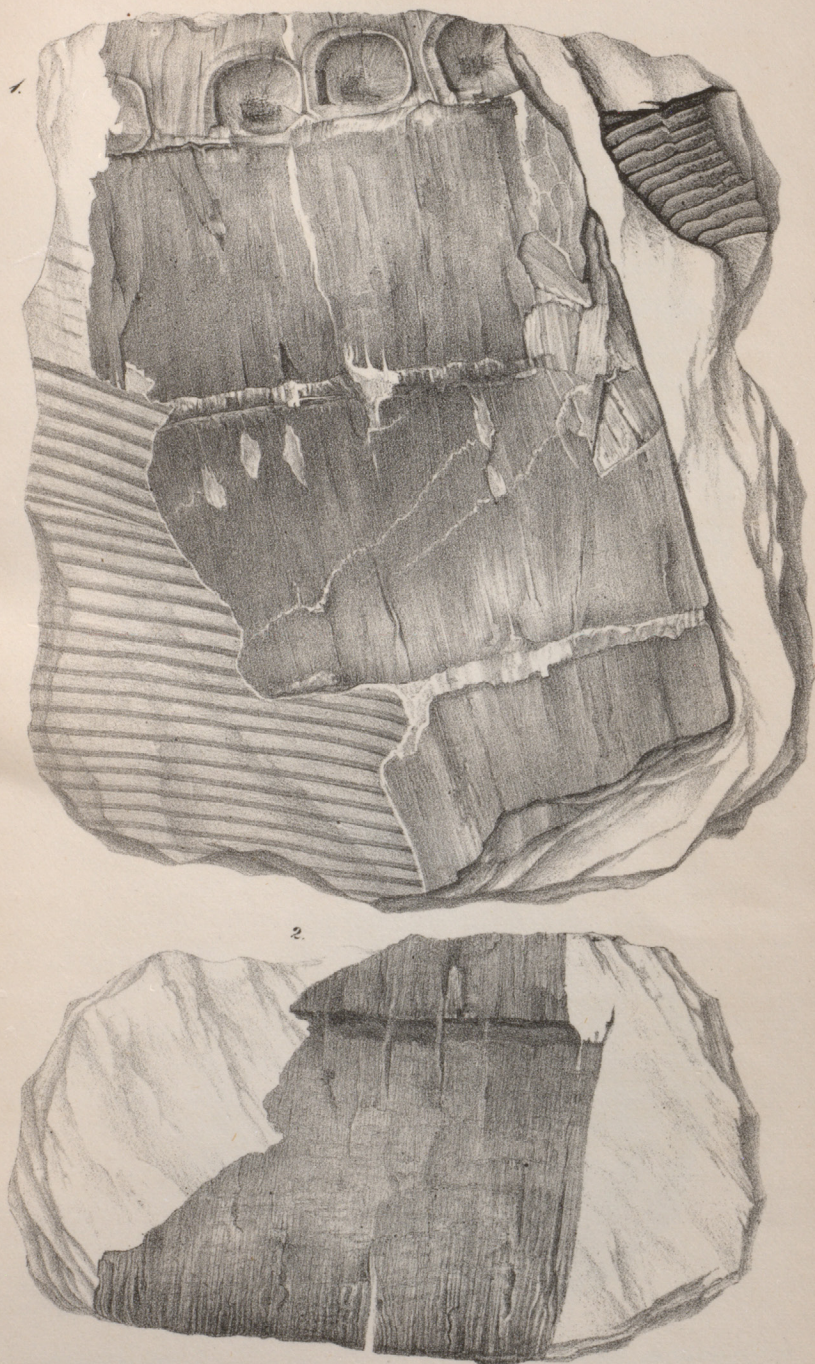
- Fig. 1. *Calamites communis* Ettingsh. von Wranowitz bei Radnitz In der Sammlung der k. k. geologischen Reichsanstalt.
Fig. 2. *Calamites arenaceus* Brongn. von der Feuerbacher Haide bei Stuttgart. In der Sammlung des Herrn Hofrathes Bronn in Heidelberg.

Tafel III.

- Fig. 1—3. *Calamites arenaceus* Brongn.; Fig. 1. aus der Umgebung von Stuttgart; in der Sammlung des böhmischen National-Museums zu Prag. Fig. 2—3 von der Feuerbacher Haide; aus der Sammlung des Herrn Hofrathes Bronn.

Tafel IV.

- Fig. 1—2. *Calamites arenaceus* Brongn. von der Feuerbacher Haide; aus der Sammlung des Herrn Hofrathes Bronn in Heidelberg.
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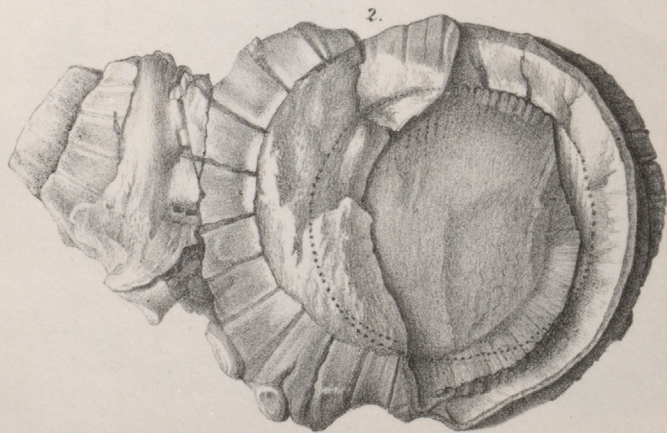


M. Sandler. lith.

Aus der k.k. Hof- und Staatsdruckerei

Fig. 1-2. Calamites communis Ett.

Sitzungsber. d. k. Akad. d. W. math. naturw. Cl. Bd. IV. 3. Heft. 1852

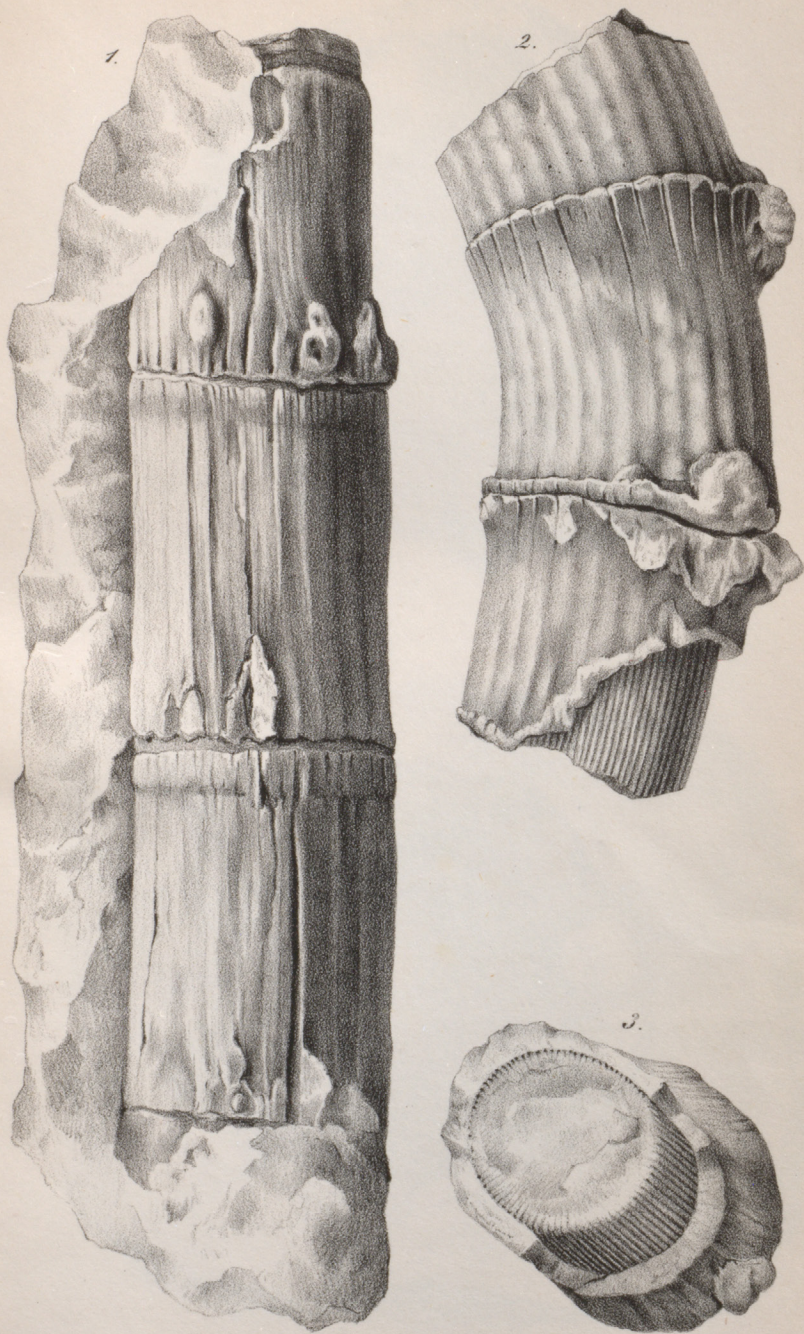


M.C. Sandler. lith.

Aus der k.k. Hof- und Staatsdruckerei.

Fig. 1. *Calamites communis* Ett. Fig. 2. *Calamites arenaceus* Brongn.

Sitzungsb. d. k. Akad. d. W. math. naturw. Cl. Bd. IX. 3. Heft. 1852.

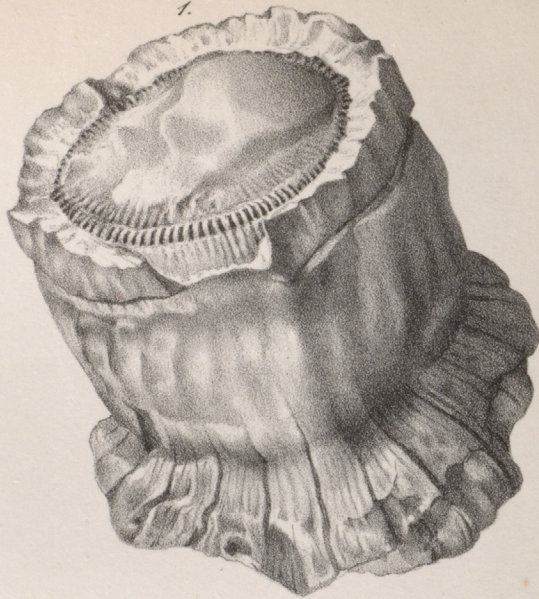


Breyer lith.

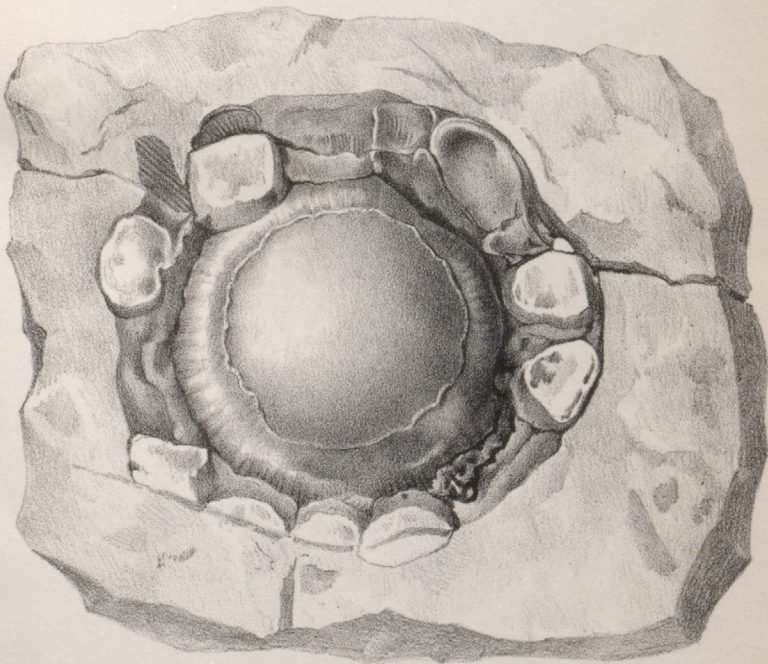
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Fig. 1-3. Calamites arenaceus Brongni.

1.



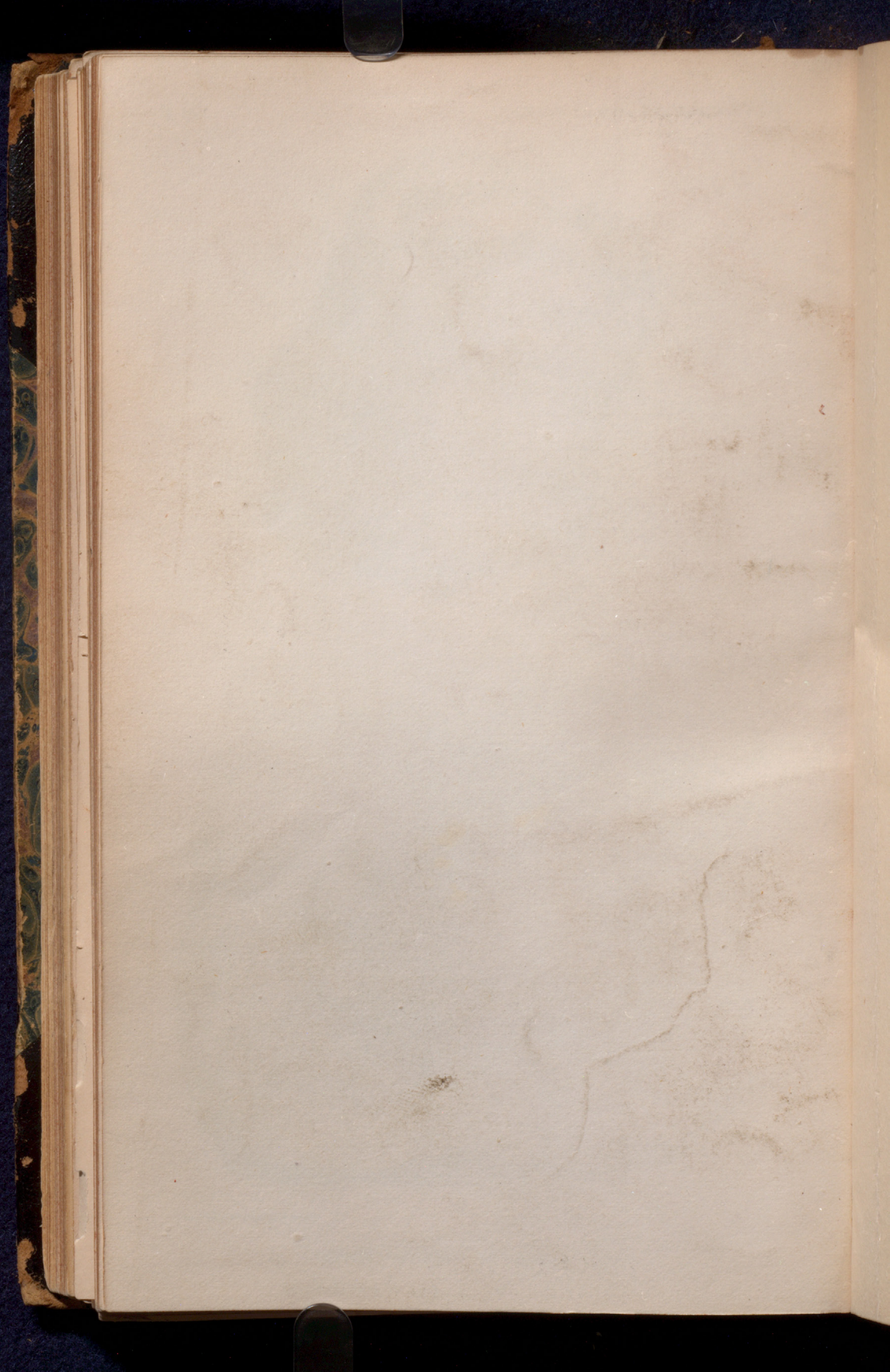
2.

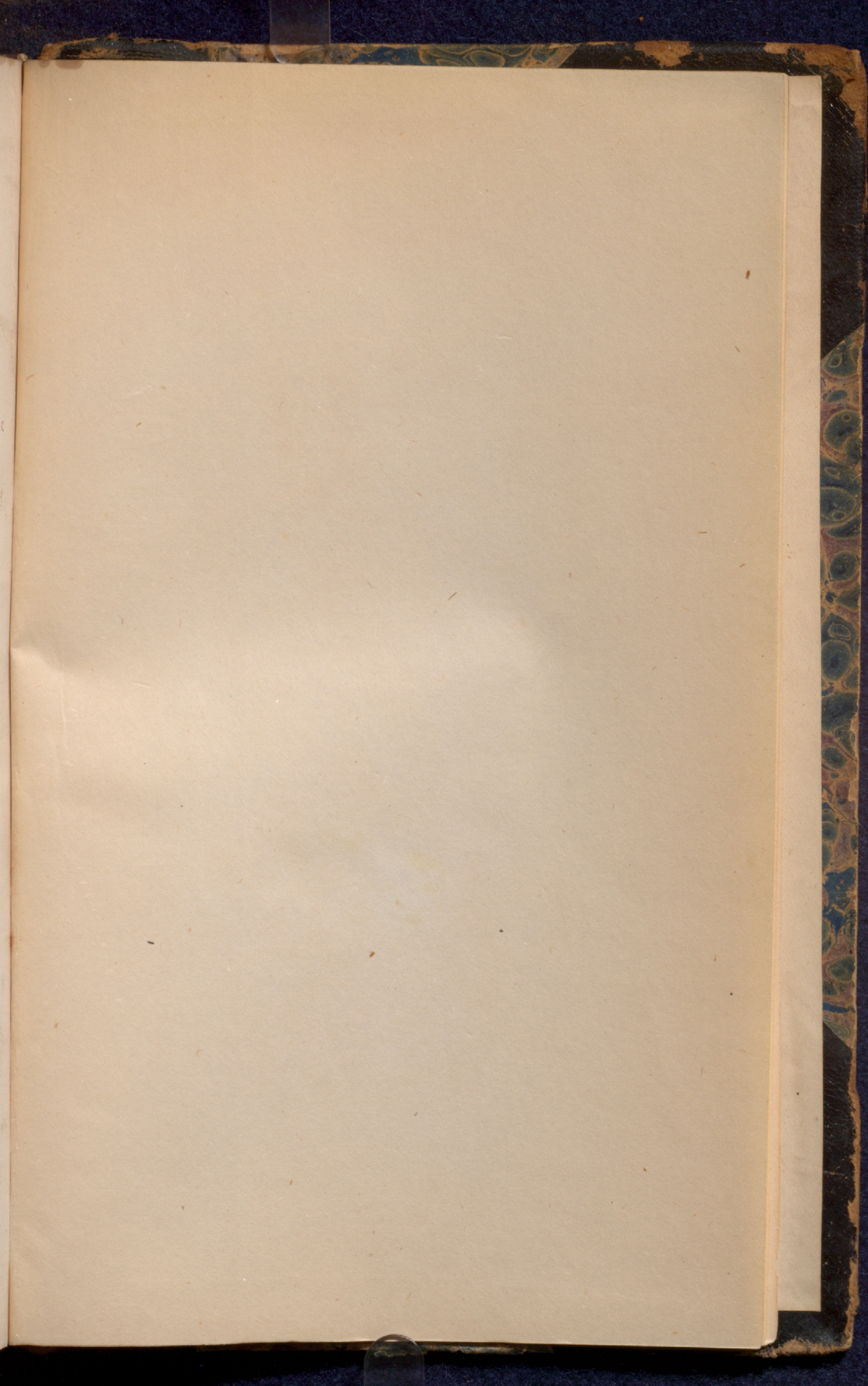


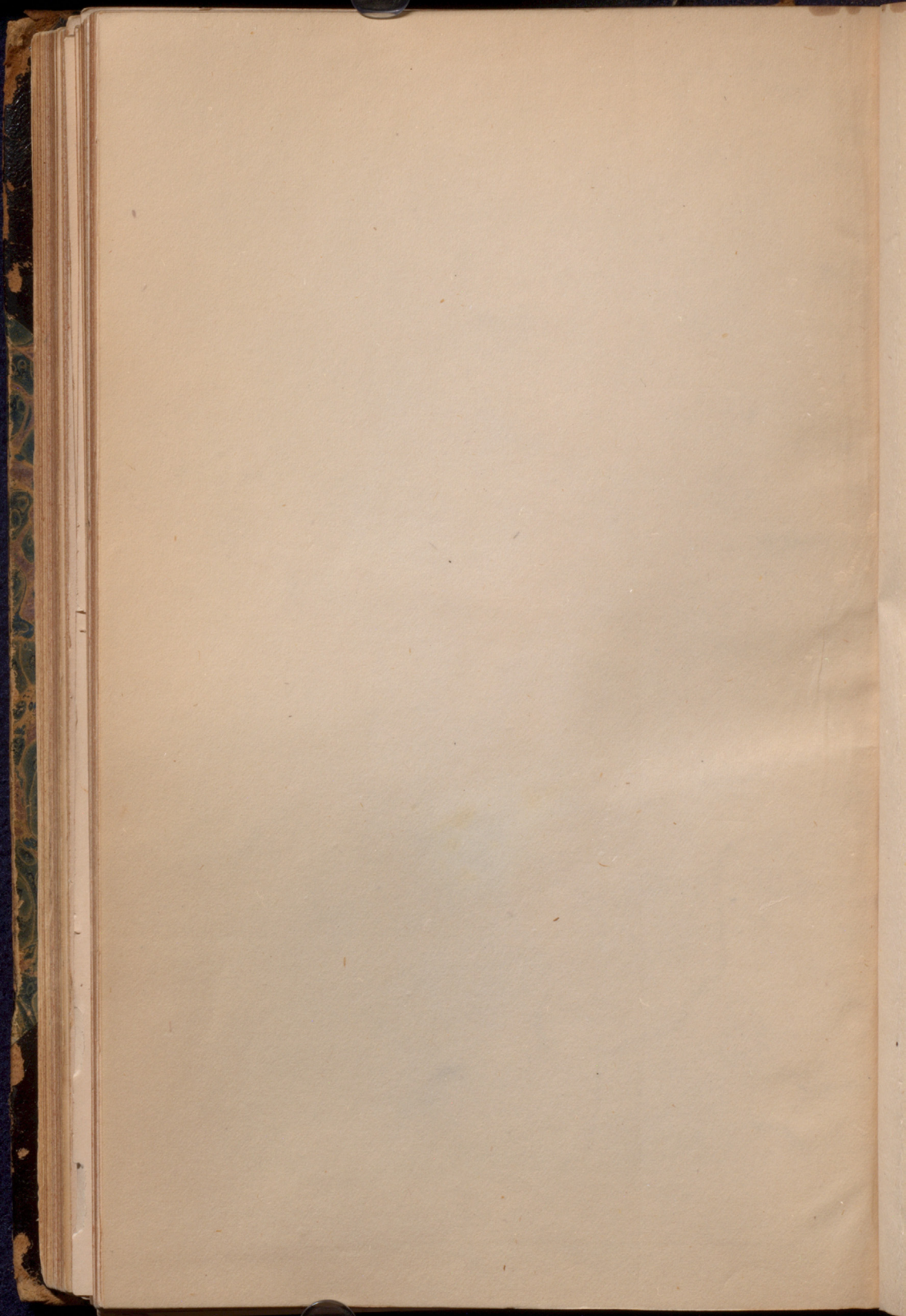
Erzogen lüh.

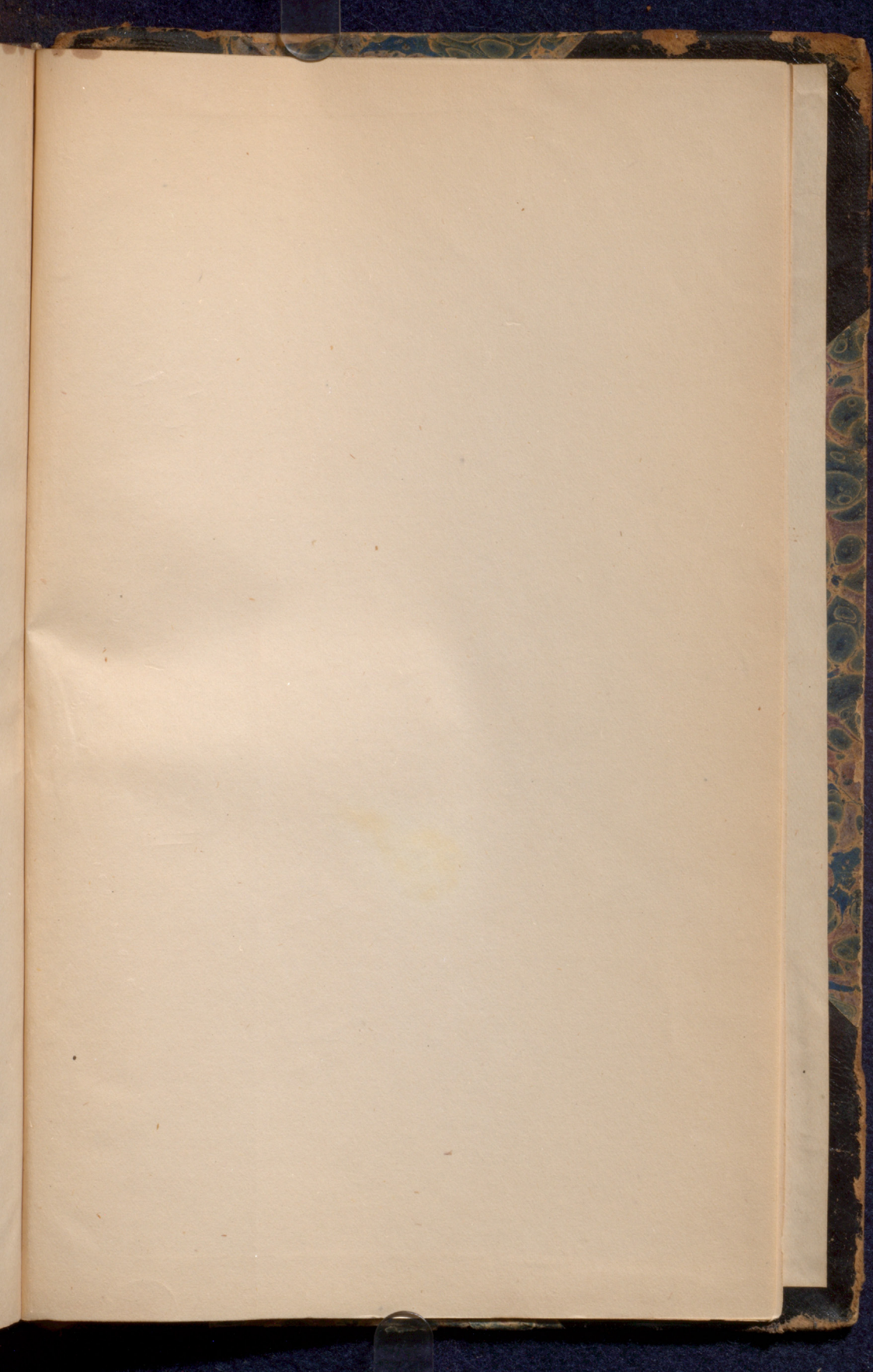
Aus d. k. k. Hof- u. Staatsdruckerei.

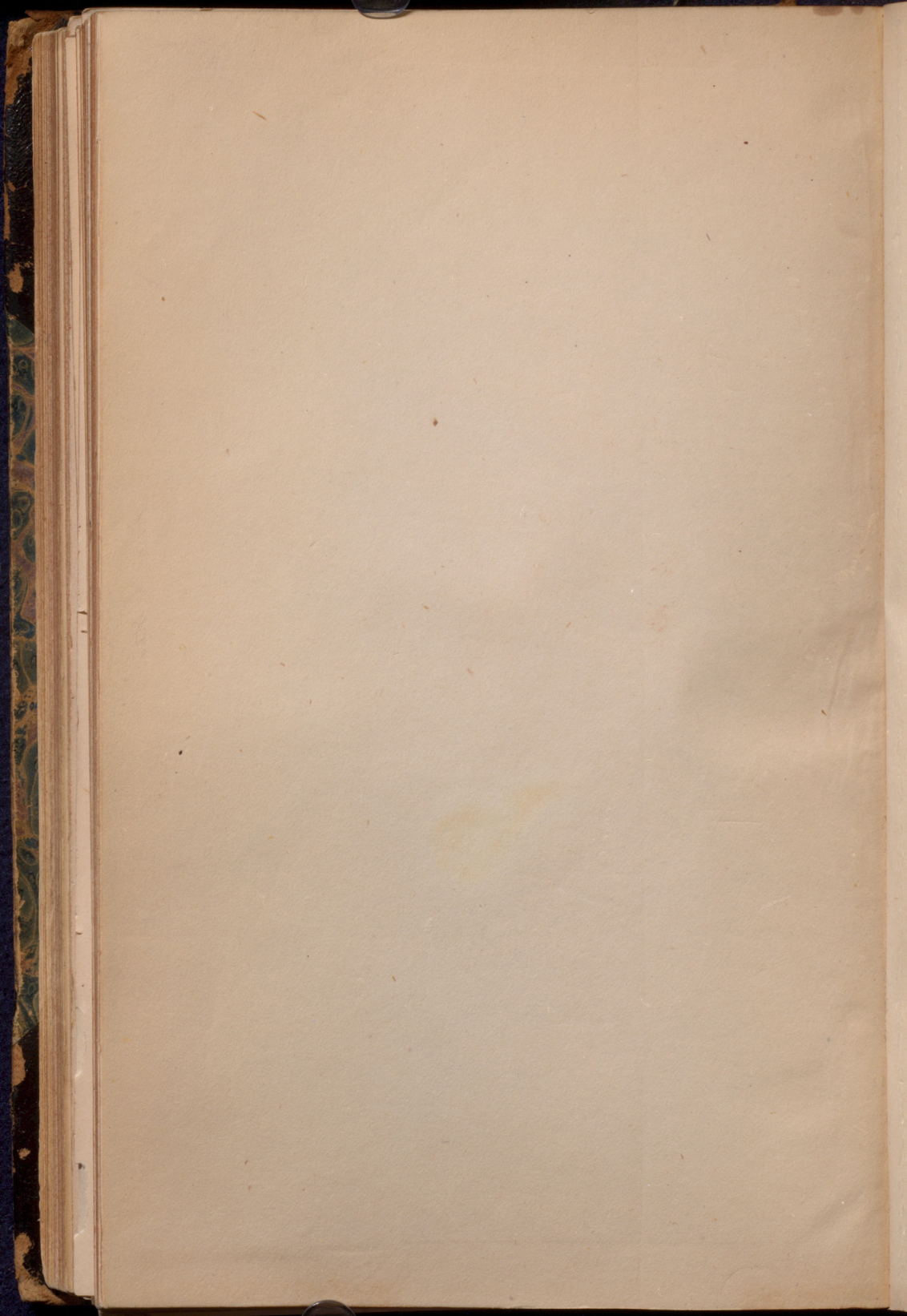
Fig. 1.2. Calamites arenaceus Brongn.

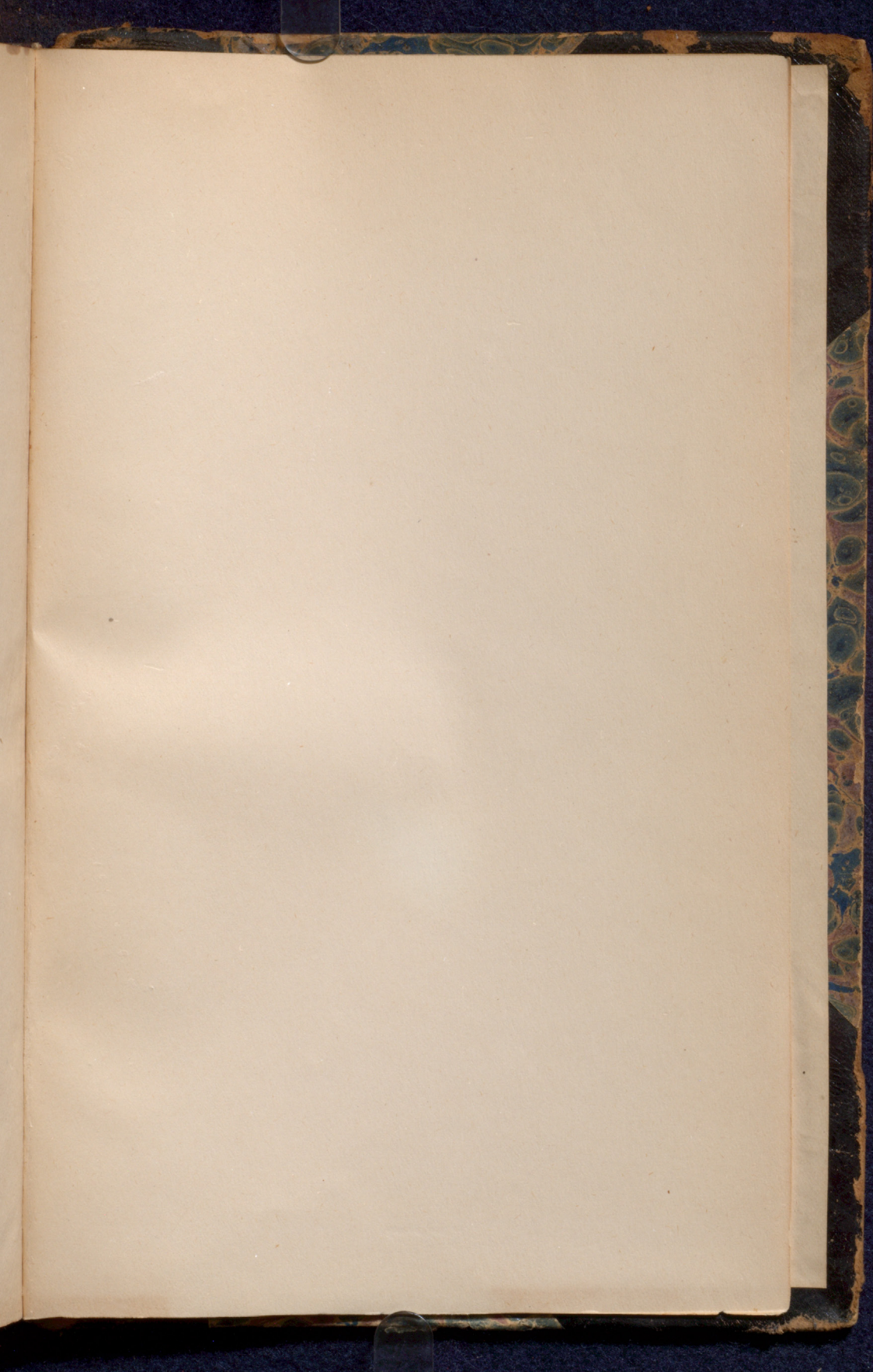


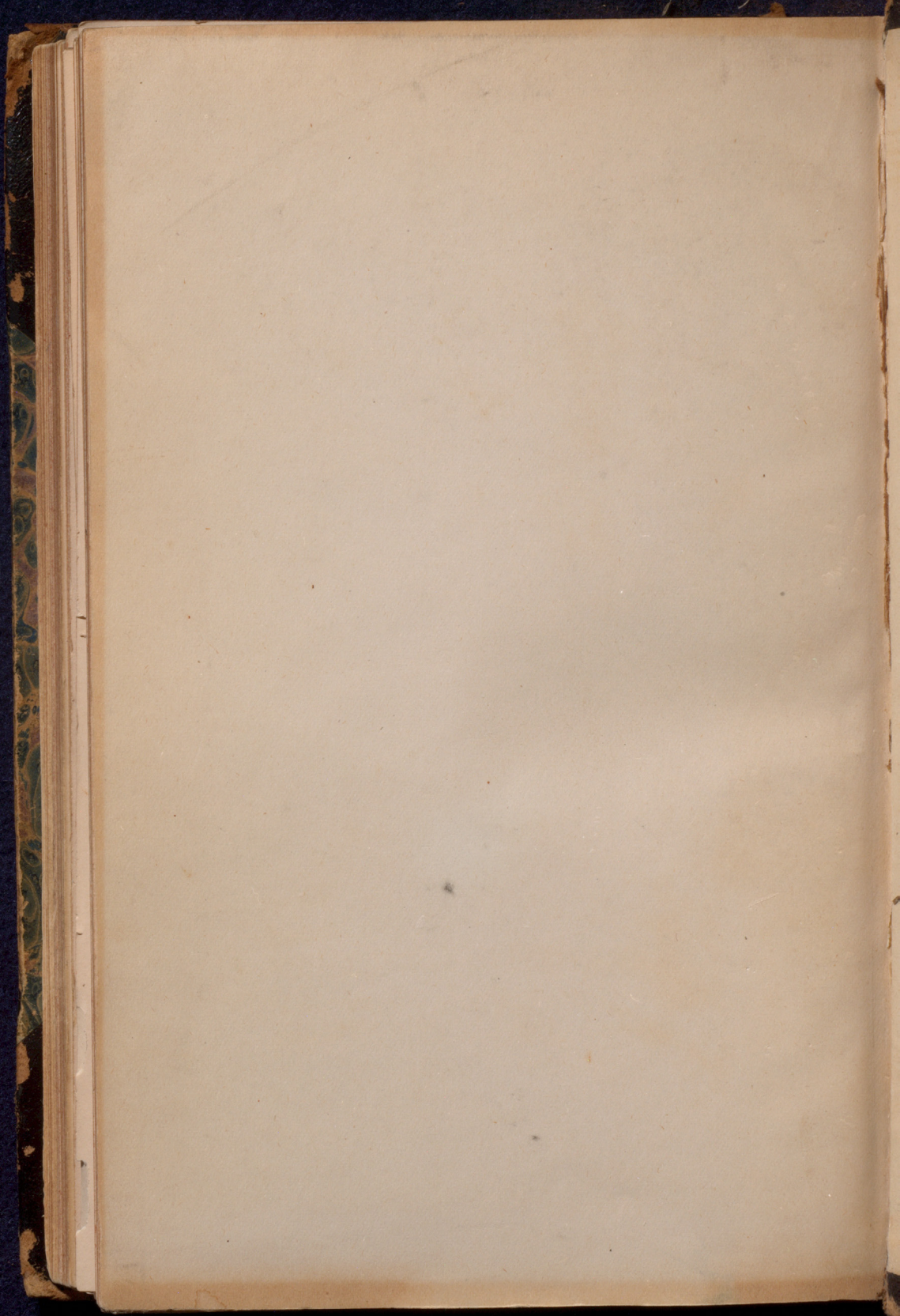












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